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ABSTRACT

As part of its General Information Programme, the United Nations Educational Scientific and Cultural Organization (UNESCO) has for many years concerned itself with training in the use of information by preparing guides and organizing meetings and seminars on the subject. There are now an enormous number of specialized information users whose working methods and documentation needs vary significantly according to their training and professional practices. At the same time, information sources and retrieval methods are geared to the history and structure of the various disciplines and the information they generate. It has therefore become necessary to set out guidelines which are relevant to different areas of specialization. The guidelines for information management for engineers in this document have been set out in two parts: Part One, "Training engineering students in information management: why and how," is a statement of the basic principles and practices of information management; and Part Two, "Examples, experiences and personal accounts as a basis for devising and setting up information management training schemes," is a sample of training schemes in 42 countries and provides an illustration of the principles in Part One. A select bibliography of 92 titles and a list of contributors organized by name, profession, and country are included. (JLB)

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Guidelines for the Training of Engineers in Specialized Information Management

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Guidelines for the training of engineers in specialized information management

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FOREWORD

Information management has become one of the principal components in the development of post-industrial society. Whole sectors of economic life make constant use of information in all its forms. Research, education, industry, commerce, finance, transport and government are all fields of activity in which those involved in economic and social life need reliable, complete, up-to-date and readily usable information.

But although the importance of information is becoming increasingly acknowledged, the actual and potential users of information systems and services are far from knowing how to make maximum use of the tools created for them, for as information needs expand, both the intellectual and technological instruments developed to satisfy this demand become increasingly complex. User training has therefore become an urgent requirement.

As part of its General Information Programme (PGI), UNESCO has for many years now concerned itself with training in the use of information - an essential aspect of the development of information - by preparing guides and organizing meetings and seminars on the subject, for the importance of user training was recognized right from the launching of the UNISIST programme.

This document - 'Guidelines for the training of engineers in specialized information management' - forms part of this endeavour and is targeted at a specific audience - engineers. We know that there are now an enormous number of specialized information users whose working methods and documentation needs vary significantly according to their training and professional practices. At the same time, information sources and retrieval methods are geared to the history and structure of the various disciplines and the information they generate. It has therefore become necessary to set out guidelines which are relevant to different areas of specialization. Bringing out a guide intended for engineers alone is therefore amply justified and follows on logically from previous activities in this area, including the recent expert meeting on the training of information users in higher education (PGI-91/WS/1).

Furthermore, one particularly original aspect of this document should be stressed. The many experiments and schemes being implemented throughout the world, not only in the developed world but in developing countries as well, clearly show that training engineers to manage information is on everyone's agenda. The guidelines have accordingly been set out in two parts: a statement of the basic principles followed by descriptions of a range of schemes originating in 42 countries covering the five continents. This sample, compiled as the result of a widespread international survey, is a unique contribution to an intercultural approach to the issue and constitutes a particularly vivid illustration of the theoretical principles and practices set out in Part One.

Our thanks are due then to Mr Michel for this innovative contribution to UNESCO's General Information Programme and it is to be hoped that this document will enjoy the success it deserves, having regard to both the originality of its approach and the needs it seeks to satisfy.

The author assumes full responsibility for the facts and opinions contained in the document, which do not necessarily reflect the views of UNESCO. The Organization hopes that readers, especially those in developing countries, will make known their views concerning the usefulness of this study and will pass on any information on experience that could assist the organization and evaluation of international schemes for the provision of information

management training for engineers. Readers are invited to send their observations and requests for further copies to:

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INTRODUCTION

Training tomorrow's engineers to manage information, teaching these students the skills needed to find the information and documents required both for their studies and for the careers they are to take up, giving them methodological rules which will enable them to retrieve, process, manage and communicate or disseminate their information efficiently - these are the goals that all those in charge of engineering training programmes are in duty bound to take into consideration as the end of the twentieth century approaches.

These guidelines for training engineering students to handle specialized information and documentation are designed more especially for rectors of technical universities, directors of engineering colleges, deans of engineering faculties and professors in various disciplines, but are also intended, of course, for the heads of the libraries and documentation centres of these establishments, who are key partners in implementing training and awareness schemes.

The starting-point: engineers and their needs

It should be made plain from the outset that this guide is in no way a new manual on what is usually termed 'user education'. Such documents exist already and their aim is to ensure the effective use of information services (libraries, documentation centres, information retrieval centres, data base servers) by their present or potential clients. But although the problem of making better use of these tools or services is a real one in many countries, the problem facing those in charge of engineering training is quite different: how to make tomorrow's engineers aware of the need for information management, whatever particular tools they may use.

In other words, this compilation of guidelines is centred first and foremost on engineers, the specific demands of their working practices, their information and documentation needs, and, therefore, on ways of including the teaching of information management skills in the general process of their initial and continuing training. We will first examine the problem from the point of view of engineers' needs, the existing demand or even dissatisfaction with current provision, and avoid focusing on the sole aspect of seeking to ensure the more effective utilization of the information services on offer.

Many schemes designed to develop engineering students' awareness of the tools and resources available in university libraries have failed and are doomed to failure because it is contrary to reason to provide a veneer of practical training in the specific resources and techniques of those libraries, when the real need is quite different and is concerned more especially with the problems of dealing with complex information environments than with the correct handling of bibliographic references.

The various people and institutions involved

This is why the question of developing students' awareness of information and training them to manage it is first and foremost the concern of those who devise programmes and courses for these future engineers, in the same way as the inclusion of management techniques, foreign languages or the theory of probabilities. Training in specialized information management should evolve in the wider context of what, at the end of this twentieth century, the role of the engineer should be (the engineer as a problem-solving professional, responsible for the marshalling or management of technologies, and for bringing about the transfer of knowledge and skills ...). Such training should be looked at in the context of the increased

internationalization of engineering practices, spectacular growth in tertiary or service activities and the increasing importance of information and communication technologies in post-industrial society.

But although this information management training must be part of a conscious and goal-oriented education policy, it should not be put into effect without the support of a good many participants, both within higher education establishments and outside them.

While the head of an engineering college must play a full part in the decision to introduce these training courses and make the financial resources available to carry them out, the teaching staff must also be deeply involved and include this dimension in their own teaching. Surely it would be a good thing for a lecturer in soil mechanics or in robotics to be the first to channel the curiosity of students towards the appropriate sources of information and documentation? And for them to require their students to produce personal work based mainly on seeking out the relevant information in connection with the disciplines they are studying? Surely it would be a good thing for engineering students to start all project work with a preliminary synoptic review, assembling and commenting on the data, information or documents of various sorts: scientific, technical, technological, economic, environmental, social, political - or concerning competition in the particular field?

This does not mean that the information and documentation specialists working in the higher education establishments should feel left out of this information training approach or philosophy. They have their part to play in a project of this nature. They can share their experience and make their professional skills available to the target group of students. The head of the university library or documentation centre and information specialists in engineering departments or faculties are and will often be the principal organizers of information management training programmes. These information and documentation specialists will have a wide range of opportunities to take part in training: library tours, teaching students how to use the main documentary tools, explaining manual or computerized literature searching, to them, developing specialized courses on the documentary sources for specific fields of engineering, introducing them to the techniques and tools of standardization, certification and patents, effective reading, scientific and technical drafting and communication, and providing current-awareness training or ensuring that engineers are alert to developments in the technological, strategic and competitive fields. But the incorporation of these training activities in the degree or diploma courses and their recognition as credit units by the institution are an essential condition for their success. Likewise, the partnership between information specialists and teaching staff should be systematically encouraged in order to avoid the often exemplary work done by these internal information specialists from being regarded as a side issue.

Apart from the categories already cited, mention should be made of many other institutions outside the college or university which can give effective support to information management training. National or regional specialized information centres or services are vital links: standardization institutes, patent offices, specialized data base servers or producers, sector-based documentation centres, industrial information or documentation services belonging to private companies, industrial archive centres, and so on. It is essential to impress upon engineering students that what they can find in the university library is only a fraction of the huge volume of information and documentation resources on which they will be called upon to draw throughout their careers. The engineering companies themselves, engineering practitioners and engineers' professional organizations also constitute a fertile source of expertise that can be tapped. The involvement of engineers and company executives in information management training programmes guards against any risk of these programmes

coming up against two snags: teaching restricted to the tools offered by libraries and information specialists ('knowing which button to press to get into the treasure-house') or else the academic presentation of information theory or science which fails to take account of the specific information problems of the engineer.

A collective contribution on a worldwide scale

In order to produce this guide, and, more especially, to conform to the principles mentioned earlier, a wide-ranging appeal was made on a world scale to gather experience, examples, suggestions and recommendations. Between 1989 and 1991 this appeal brought in 50 major contributions.

It was regarded as essential to review what was being done in the area of specialized information management training, while avoiding any concentration on a single approach developed in any one group of countries. The experience of the technical universities and engineering colleges in the industrial countries is very interesting, but that of establishments in the developing countries of Africa or Asia is no less so. It is interesting to compare the experiences of English-speaking countries or countries with British or American-influenced cultures with those of French-speaking countries or those with Latin cultures. If Europe seems to predominate, however, with more than half the contributions, the main reason is that the author's sources of information are largely based on European networks, strengthened over the past few years by the prospect of the creation of the single European market. It must however be pointed out that many advanced experimental schemes in the training of engineers to handle information were created or developed in European establishments. The fact that the European Journal of Engineering Education of the European Society for Engineering Education (SEFI) published two special issues on this subject in 1987 and 1991 demonstrates the surge of awareness in Europe of this new dimension in engineer training.

It was also important to collect ideas from as broad a range of professional groups as possible. A wide variety of specialists or practitioners were asked to contribute their views: heads of engineering colleges, teachers of scientific disciplines - technical and non-technical - heads of technical university libraries, information specialists, practising engineers and representatives of engineers' organizations. The multi-professional nature of this approach must be stressed and goes a long way towards explaining why this guide differs so much from the traditional user education manuals which take the viewpoint of a single profession. Librarians and documentalists in technical universities and engineering colleges have provided nearly half the contributions, but it is interesting to note that almost an equivalent amount of information was communicated by engineering professors and practising engineers concerning their experience.

Several groups or networks were asked to contribute and responded in a very relevant and positive way. The World Federation of Engineering Organizations and its Engineering Information and Documentation Committee (plus, to a lesser extent, its Education and Training Committee) informed us of experiments - often original - carried out in every continent. Members of the Information for Industry Committee of the International Federation for Information and Documentation (FID) were also asked to help. The International Association of Technical University Libraries (IATUL) encouraged contributions from its members; they provided the specific point of view of heads of university libraries who had devised information management training for engineering students. In Europe the European Society for Engineering Education, which has some 500 members drawn from the ranks of heads of engineering education establishments and engineering professors, was a key source of contacts with people who have set up original documentation and information programmes for

engineers. Other partners and networks could also be mentioned, such as the International Development Research Centre, the informal international group 'Improving University Teaching', the 'Mediances' association in France, the Engineering Information Committee of the French National Council of Engineers and Scientists, the 'Conférence des Grandes Ecoles' in Paris, documentalists from engineering colleges in French-speaking developing countries, former students of the Bordeaux International School, and others.

Lastly, the international organizations, particularly UNESCO, UNEP and UNIDO, have helped in providing access to some vital sources of information.

PART ONE

Training engineering students in information management: why and how

1. ENGINEERS AND INFORMATION

1.1 Engineers and the transfer of information

What characterizes the situation of the industrial countries today, when we compare it with that which prevailed in the mid-nineteenth century, is the mushrooming of information and communication in every dimension of individual, professional and social life. This fact is now central to the engineer's everyday work. The engineer is increasingly acting as a vector for the transmission of relatively complex information between individuals or groups who either ask engineers to solve problems or tell them what is needed (society, industry, the public at large, political authorities) and those who come up with practical solutions - technical construction firms and manufacturers and distributors of products. Engineers, whether research-inventors, clients for whom work is carried out, prime contractors, technical-commercial agents, company directors or inspectors, are clearly at the crossroads where specialized information of all kinds is exchanged and processed. Engineers do not manufacture the materials and equipment they procure, but they do manage the information systems which aid the decision-making process and enable appropriate answers to be found in regard to the needs that have been expressed. Engineers are constantly steering a course in a sea of information; they transform this information and produce plans and projects which are simply the expression, at a given moment in time and in terms of practical information, of solutions geared to their clients' expectations. Engineers also act as a channel for information, selling their projects or defending them, seeking to convince other partners and decision-makers. It is very revealing to observe and listen to engineers talking in trains or planes: the exchange of information comes thick and fast and it becomes obvious that without this pooling of information engineers would be unable to do their jobs.

More broadly speaking, it is clear that specialized information systems are becoming both increasingly powerful and impossible to do without. From the use of data bases and data banks to expert systems, including computer-assisted design and manufacture, trans-border data flows, standardization, certification or patents, the whole range of activities of companies and engineers is set within the context of the development of their information resources, the real spearhead of today's production and service industries.

It is important to stress, furthermore, that this 'professional' (scientific, technical and economic) information is not the only factor that modern companies (what Serieyx called 'companies of the third kind') must consider. Account now has to be taken of the legitimate means of expression of employees (in the form of quality circles and progress groups). The indispensable dialogue with partners from different technical or geographical cultures must be organized; mass communication with the public at large must be handled and political communication with the decision-making authorities ensured.

But in referring to culture, surely it is essential nowadays to speak of a heritage of knowledge in respect of the information shared by company engineers, managers and technicians? Engineers' knowledge and know-how are becoming assets which it is no longer possible to overlook or discard through muddled thinking or ignorance. Industrial secrets, protection of intellectual property, the optimum use of knowledge and its transfer, and the communication of specialized information are all lines of approach that must be stressed in what is now known as a business culture.

1.2 The training of engineers and the information issue involved

In these circumstances, the question of engineering training assumes particular importance and cannot be restricted to giving a 20-year-old a 'kit' of hard-and-fast facts. Whereas in the middle of the nineteenth century the role of training institutions was obviously to give students access to little-known technical data and to standardize levels of knowledge among a few groups of engineers, this is no longer the case, for nowadays, at least in the industrial countries, anyone can gain access to any fact and any information, including data in sources at the furthest points of the globe and information that is supposed to be confidential.

To be simplistic and deliberately provocative, one might say that it may no longer be necessary today to rely on technical colleges and universities to train engineers. Or to be more precise, it may no longer be essential to assemble students in one place to instruct them and provide them with access to information which is now easily transferable. If, then, engineering colleges and technical universities are still to have a purpose, for what functions and services should they be designed?

Is it simply a matter of providing, in a lecture theatre, information which is freely accessible from any point on the face of the earth? Should not the aim be to establish links between scattered and contradictory knowledge, create a specific cultural life and help stimulate the production and transfer of knowledge? What, then, is the appropriate role for an engineering college or technical university at the end of the twentieth century?

This question is central to the thinking of the engineering school authorities and teaching staff who are concerned with the training of engineers and are trying to get to grips with what would be involved in introducing information methodology into a new programme to train engineers for today's world.

Essentially, it is surely time to make a clearer distinction between all that has to do with the transmission of the data or information which make up knowledge and skills, and all that is involved in the transmission and consolidation of knowledge of a structural kind and the preparation of engineering students to handle the methodologies they need to work efficiently.

Looking at the training process as a whole, it now seems vital to ensure that tomorrow's engineers know how to improve their skills at managing their own systems of access to information and knowledge and how to set up their own procedures for processing and communicating these data or documents. In other words, they should learn to define their own 'quality' procedure for managing the information and documentation relevant to their studies. With this in mind, the first step in any engineering training process should be visits to libraries and documentation centres, the consultation of data bases and data banks, and the critical scanning of many studies and articles in a range of languages. This would make it possible to reduce, without a moment's hesitation, many basic courses and much subsequent trainir which are essentially compilations - inevitably incorrect or incomplete - of information which is often outmoded or obsolete by the time the course is given. This deep involvement in the information process (which, while undoubtedly necessary, is not on its own sufficient to constitute a complete teaching project) should of course be organized, managed and monitored. Facilities must be provided at various points in the cities concerned. It would certainly be desirable, for example, for Marseilles, Helsinki, Tunis and Bogotá to have information clearing houses for the various engineering colleges or technical universities in those cities. Arrangements for tutoring and assessment of the learning process would have to be made so that students could measure their progress in absorbing this self-acquired knowledge, since training consists of more than the mere transfer of information and facts.

Such information and/or learning resources may have a variety of origins and the different engineering training programmes should encourage students to steer their own course through this new information 'hyperspace'. The traditional resources - books, journals and non-conventional literature - should of course be given priority. But nowadays CD-ROMs, data bases and data banks, video discs, satellites and distance education are all efficient alternative access routes to information and knowledge. Contacts in the world of industry, exchanges with foreign partners, working with technicians or specialists in other disciplines and developing extra-curricular cultural activities also provide new opportunities to enrich students' personal data bases.

Would it not be a good idea to think today in terms of networked individual learning workstations giving the student all the facilities available nowadays through microcomputing, the use of telematics, word-processing software, hypertext or hypermedia tools, CD-ROMs, digitalization and electronic archiving, faxes, electronic mail or even satellites?

Would it not be a good idea to require engineering students to create, manage and build up their stock of information resources themselves? Making these budding engineers responsible for setting up their own knowledge bases and information systems would seem to be fundamental in the new context of the engineer's role as technical and economic intermediary.

An engineering course should basically consist in the provision of a system of organized, guided, but personalized access to the relevant information or knowledge. Naturally, alongside the bare provision of means of access to information sources, the college or technical university responsible for a engineering training course should introduce ways of consolidating the knowledge being acquired (practical work, personal or group projects, educational exchanges), inculcate knowledge of a structural kind as well as basic skills and know-how, and measure students' results against the goals set. There is no doubt that the institution must also be responsible for training students in the methodologies of collecting, processing, storing and disseminating the relevant information.

1.3 Inadequacies and shortcomings observed

Looking at the problem from another angle, that of the ability of engineers to understand the challenges, methods and tools of modern information resources and make full use of them, we must unfortunately conclude that the reality comes nowhere near to matching the ideal.

It is obvious that very few engineers and technicians use libraries or documentation centres and even fewer consult data bases or data banks. Their information access practices are archaic, unoriginal and informal and inevitably lead to a mismatch between the supply of information and engineers' demand for it.

Many professionals, particularly engineers, are constantly producing specialized information and documentation (results of laboratory tests, synopses, reports) but, apart from efforts by a few major industrial companies, nothing is done by way of effective archiving to manage this body of information and documentation correctly. In this respect the situation in the companies or government administrations of developing countries is frankly catastrophic.

The large majority of engineers do not know the fundamental rules governing the protection of their ideas, knowledge, skills, inventions and innovations. They are often completely unaware of the standardization or certification procedures which are now among the essential tools of international competition.

These same engineers, and not only the older ones, usually have serious difficulty in sifting out the essential facts they need from the superabundant flow of information and documentation. They do not find it easy to use statistical analysis or any other tool to identify general laws of behaviour from a mass of heterogeneous data.

They also find it very difficult to exchange specialized information or communicate with others, whether decision-makers or experts in different disciplines. They are not familiar with communication across language and cultural barriers. Business managers often mention their poor technical drafting skills and their inability to summarize their ideas and projects.

We could go on to make a long list of shortcomings which in fact all boil down to one and the same question: have engineers ever been taught how to face up to the demands of efficient utilization of information? Have they ever been provided with training in managing their information and documentary environment? Has it ever been explained to them what the role of an engineer really involves, how specialized information is the essential raw material of this profession and how the engineer's task consists largely of working with and transforming information?

2. TRAINING IN SPECIALIZED INFORMATION MANAGEMENT

Training in information management should be examined in its context. To be more specific, it should first of all be defined (what are we talking about?), then studied from a certain historical angle (where is our point of departure and where are we going?) and finally assigned a new place in the context of the development of engineering training itself.

2.1 Clarification concerning terminology

We should straight away clarify the terms concerning what could be called training in information management or, more precisely, the training of engineers in the strategic management of information and documentation.

(a) Information and documentation for engineers

Where engineers are concerned, what is termed specialized information here includes everything pertaining to the knowledge, know-how and practice of their profession. Of course this means information that could be described as scientific, technical, technological or industrial, but it also covers everything related to the environment in which they work: the company, the market, competition, technologies, costs, human resources, international law and so on. Obviously we are referring here to information in the form of data, symbols, facts, figures, plans and concepts, but also to documentation - a great deal of documentation, such as written material, tables, drawings, notes and reports, and, furthermore, to software, files, diskettes, slides and magnetic tapes.

Engineers need both raw data, such as facts, figures and diagrams, and processed information made available on various media, such as documents, reports, summaries and bibliographic references.

This useful information is inevitably complex and multidisciplinary, reflecting contrasts and sometimes even contradictions.

It is channelled in various ways: through personal contacts and exchanges, formal and informal meetings, written and audio-visual media, calculations and formal documents such as patents and standards. It is made up of a whole set of data and documents produced within the company itself (the engineer's single most important source of useful information) and of information and documentary resources from outside the company (rival companies, customers, the latest technology, reference works, general publications and articles in trade journals).

It should be made clear at this juncture that the information of value to the engineer is not the same as that traditionally required by the researcher or scientist, who does not have the task of designing products or services which will satisfy the requirements of financial backers or prospective clients. Documentation or information of use to the engineer can in no sense be reduced to what is available on the shelves of a university library. Books and articles are often of little practical value to engineers. There must, therefore, be careful analysis and assessment of their information needs, which are often closely connected to their everyday activities, prior to the establishment of training programmes which may prove inappropriate or unsuitable.

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(b) Handling and management of information

These terms clearly mean that we must concern ourselves with all the activities involved in the information process, and not simply with the question of access to information - and to an even lesser extent, with the sole or exclusive retrieval of bibliographic or documentary references, using either computers or traditional methods. In other words, we must take as great an interest in the production, utilization and communication of information as in its retrieval and passive use. This leads us to such complex questions as:

how do engineers produce information?

how do they set out and distribute it?

how do they decide on targets for distribution?

how do companies subsequently manage the information and documentation they have produced?

how do engineers formulate their information requirements?

how do they organize the process of data or document searching as part of their everyday work?

how do they obtain access to information from other than the well-known, traditional sources?

how do they produce consolidated information so as to enable them to design goods or make decisions?

how do they manage their stocks of information and documentation?

what links do engineers establish between the various information systems (from technical images to geographical or cartographical information, and including systems to aid decision-making and computer-assisted design tools)?

Information handling and management clearly mean dealing efficiently and intelligently with supplies and flows of useful information, making assessments in economic and policy terms of the various information solutions available, and ensuring the participation of the professionals and others involved in a company project focused on the most effective use of human resources and the development of the stock of information, documentation and knowledge.

(c) Strategic management of information

We must think, indeed, in terms of strategies and not just in terms of tools and resources, however sophisticated these may be. It is obvious that the engineer's information is strategic. The engineer is a decisive element in the company's functioning, and the engineer's information needs represent a major part of the information needs of the company for which he or she works. Information management is not just a question of the engineer's personal concerns, but should be viewed within the context of company strategy, account being taken of all the factors of competitiveness and the whole range of constraints affecting the company. The information

needed by an engineer, or rather by groups of engineers, is information concerning the company's products and, therefore, its development in the medium and long term.

Engineers transform information and knowledge to enable goods or services to be produced by the company. The strategic management of specialized information is that essential ability which engineers must possess if they wish to play to the full their role as vectors of change within companies.

2.2 Historical background to information training for engineers

It is not the purpose of this document to provide a detailed bibliographic or historical study of how information awareness was introduced into the training of engineers. Nevertheless, a few important dates may be briefly mentioned.

According to Geneviève Lefort, who has studied more especially the question of student training in higher education institutions, it was in the early 1970s that concern about the teaching of scientific and technical information methodologies became more clearly apparent all over the world.

But in point of fact, close scrutiny of the archives of French engineering colleges which were established between 1747 and 1850 clearly shows that great important was attached at that time by the directors of these colleges to information and documentation for engineers. It is striking to note the interest taken by these great engineers who were in charge of the earliest French engineering colleges, in the building up of extensive documentary resources for teaching purposes, the publication of specialized journals and periodicals, the active participation of their establishments in international exhibitions, the use of the latest methods of reproduction (lithography, photography) to spread knowledge, and the search for information beyond national borders by means of missions carried out by students or engineers. This glance at the past shows the vital importance of information and documentation for the engineer, at the same time making our sometimes fanatical insistence on 'training the users' of information services and libraries in modern or post-modern times seem more ambiguous or even paradoxical.

To come back to the last 20 years, it is essential to bring to mind the efforts made by UNESCO, within the framework of the UNISIST programme, to ensure the more efficient use of the information services available, particularly in the areas of scientific and technical information. Consolidated reports by some experts (especially the Polish engineer W. Pirog, and A. Daumas in France) highlight experiments carried out in both western and eastern Europe, the United States of America and Canada. One important document is the thesis published in 1976 by Nancy Fjällbrant, who specialized in user training. In the United States major efforts have been made over the past 20 years to introduce student training in the mechanics of acquiring specialized information. But overall these experiments and activities have concerned only a minority of engineering students whereas more effective work seems to have been done in the areas of medicine and chemistry.

It is interesting to note the efforts made in France since the mid-1970s, and in particular the establishment of the Bureau National de l'Information Scientifique et Technique (BNIST) which subsequently became the Mission Interministérielle de l'Information Scientifique et Technique - MIDIST - or the Interministerial Mission for Scientific and Technical Information. Working in conjunction with the Conference of the French 'Grandes Ecoles', they set up several schemes to promote awareness of the need for scientific and technical information, including the

organization and financing of a major programme to introduce students at the 'Grandes Ecoles' (in engineering and commerce) to computerized information retrieval procedures. The 1980s saw a further increase in France in the number of original projects in this area, some of them differing markedly from the traditional methods of teaching students how to make the best use of library resources and tools. These activities were the subject of a work published by the Conférence des Grandes Ecoles in 1987 entitled 'S'informer pour se former et pour agir' (La Documentation Française).

It is also of interest to point out that among the engineering community itself and especially within the World Federation of Engineering Organizations, consideration of this issue began in the 1970s and, towards 1985, led to various round tables and seminars dealing with the training of engineers in information management.

At the strictly European level, mention should be made of two special issues of the European Journal of Engineering Education:

in 1987, 'From Engineering Information to Engineering Education' (Vol. 12, No. 2);

in 1991, 'Integration of Information Management Skills within the Engineering Curriculum' (Vol. 16, No. 3).

In 1991 UNESCO organized a meeting of experts at Espoo, Finland, on the training of information users in higher education.

The annual conferences of the International Association of Technical University Libraries (IATUL) and its journal, 'IATUL Quarterly', have made an important contribution over the past ten years to the development of an original process of reflection on training engineers in information management.

2.3 Differing views of the role of the engineer

Before we turn to the issue of training engineering students in information management, clarification of what is meant by the term 'engineer' is called for; more especially, the various forms engineering training takes in different countries should be specified. Obviously the extent to which future engineers need to be made aware of or given training in information management will depend on how others see the professional role of the engineer. A distinction often needs to be made, then, between engineers who are company managers, product designers, researchers (bearing in mind that researchers do not constitute the majority of engineers), technical and commercial engineers, production engineers and even engineering technicians.

How the role of engineers is viewed varies according to whether they are regarded as 'general' engineers or specialists, and whether they are working on the technical side or in management.

In the United Kingdom and countries influenced by its traditions, the engineer is regarded as a kind of 'super technician' who designs or manages technical objects. The semantic link between 'engine' and 'engineer' is direct, natural and deeply significant. These countries have high-powered organizations of engineers which guarantee the technical skills of their members and publish journals enabling members to keep constantly up to date with the latest technical developments. Historically speaking, formal training in engineering emerged relatively late in

these countries since engineers traditionally acquired the technical knowledge they needed 'on the job'. The disadvantage of this pragmatic and technical approach to the training of engineers is undoubtedly the scant importance attached by society to the profession, its relatively low status and the distrust with which the professional community regards university institutions offering qualifications in engineering. It should be pointed out that in the current debate on harmonizing training within Europe, the British tradition of a short period of academic training for engineers (usually three years, sometimes four) is seen as a major obstacle.

In other countries, such as Germany and some countries of central and northern Europe, the engineer is traditionally regarded as first and foremost a scientist, that is, a high-level specialist in a particular scientific discipline. According to the ideas introduced at the start of the nineteenth century by Wilhelm von Humboldt, laboratory and research work are an essential part of higher education. In principle, engineers trained in German technical universities get a large measure of 'exposure' to research and science, whether pure or applied. The period of study is generally lengthy (six to seven years) and individual work is developed to a considerable extent. Since the 1970s, however, Germany has introduced more varied forms of training, particularly a new category of qualification, the purpose of which is to train production engineers along more practical lines so that they will be more immediately useful to companies and have full command of sector-based technologies. This short form of training (three and a half years) is provided is many specialized schools (Fachhochschulen).

In the French tradition, also found in some African countries and those with a Latin culture, the engineer is expected to provide an overall response to the needs of citizens and society. Engineers have an influential role in society, marshalling techniques and managing a wide range of resources. Engineering training therefore emphasizes multidisciplinarity and an approach that takes account of the needs expressed and the economic aspect. It is generally based on extremely selective admission procedures as regards engineering school candidates and the period of study is from five to six years.

It is evident that the information and documentation needs of engineers will vary in these different countries or groups of countries. In the United Kingdom, priority is given to technological data and tools for passing on practical know-how, whereas in the German technical universities there is greater emphasis on documentation of a scientific and technical nature. In France, teachers seek to make students aware of the importance of economic, industrial and strategic information.

2.4 The changing face of engineering training

Whatever their country of origin, engineering studies are strongly influenced by the conditions in which the establishments responsible for training the first generations of 'modern' engineers emerged, especially in Europe, during the second half of the eighteenth and the first half of the nineteenth centuries (the European Journal of Engineering Education devoted a special issue in 1981 to the origins of engineering training systems in Europe).

Historically, it was in France that the training of engineers first became a matter of concern. From the middle of the eighteenth century the engineer, the perfect example of the 'cultivated man' was trained with the basic purpose of helping to run the affairs of the kingdom, State, or, later, of industry. A member of the country's élite, the engineer played a part in most of the great adventures of the nineteenth century, whether industrial, scientific or colonial.

Engineering training, steeped in the philosophy of Saint Simonism and later in positivism, developed in such a way as to strengthen the influence of engineers on French society; it also moved towards an increasing and ever-diversifying number of specialized scientific and technical disciplines, to such an extent that the proliferation of engineering colleges became inevitable. The 1934 law that introduced the regulation of engineering training is indicative of the concern of both politicians and industrialists to regain control of the virtually spontaneous spread of colleges and other institutions seeking to train engineers. The Ecole d'Ingénieurs, created by a central power anxious to maintain control of the country's technical, industrial and economic activities, still, in 1991, sets the standard in France, even though new university programmes leading to the award of engineering diplomas, now exist (in fact, the structure, lines of approach and teaching methods used in these courses are exactly the same as those of the traditional 'Grandes Ecoles'). The chief characteristics of these institutions are their selectivity, the socio-economic objectives of their courses and their 'macro' approach to education - that is to say, their ability to incorporate, in a goal-oriented and flexible way, various course components ranging from traditional studies to experience in the field, in-company training and study abroad, and not forgetting introductory courses in handling information.

In the case of the German, British, Dutch and American technical universities, which are still basically large-scale machines for generating and transferring knowledge influenced by the positivist concepts of the nineteenth century, the historic model goes much further than its French counterpart in dividing up and separating areas of knowledge. The specialized professional aims assigned to the training and the importance placed on expanding scientific research have inevitably led to the Balkanization of disciplines and the emergence of cliques and professional preserves, leading ultimately to training objectives being relinquished in favour of the noble pursuit of research. Indeed, the latter aspect is causing serious concern to specialists in the United States and Canada, who see with some alarm that the major technical universities are not training the qualified engineers with communication skills that their industries need.

There is no need here to go into the disastrous situation of engineering training in developing countries. The observations made in the nations of the north apply equally, and even more painfully, to them.

Nowadays, it can justifiably be said that the institutions responsible for training engineers increasingly fail to understand the actual needs of modern societies, and that they are not taking part in the real processes of transformation in those societies (we are thinking of the alarming developments in large cities and suburbs and the need to protect the environment). And if engineering schools and institutions turn a deaf ear to the pleas of political and industrial leaders, it is mainly because they do not know how to break away from their academic, scientific and corporative traditions. The content of courses, the power struggles concerning the dividing up of the various disciplinary territories and training based on the reproduction of knowledge are all obstacles to the far-reaching reform of education. The consequences of the information and communication revolution often seem to be little understood in engineering colleges and technical universities.

Once we move beyond the stage of blind self-congratulation, criticisms are often voiced concerning the training of engineers, alleging an over-academic approach to training with heavy work-loads for students, overcrowding in the major technical universities, inability to include access to communication resources in training programmes in an up-to-date way, lack of courses with a view to training mixed and transdisciplinary teams (technicians working alongside engineers, documentalists and sociologists), and the real difficulty of training engineering

students to use effective methodologies in the intellectual aspects of their work (such as problem-solving, creativity techniques, heuristic processes in information seeking, systems analysis and leading mixed teams).

On the other hand, efforts are constantly being made by various people or institutions involved in the education system to try to improve engineering training and match it to current needs. Over the past 20 years, for instance more systematic use has been made of training periods in firms, individual projects, exchanges with foreign counterparts, extra-curricular activities and utilization of modern tools, particularly computers, which have now 'taken over' engineering schools. Continuing and in-service training has also progressed.

Increasingly often, establishments involved in training engineers fall into the trap of promoting their outward image when in reality there has been no investment in educational research, the training of teachers or future-oriented studies. The institution's image takes precedence over its ability to find the right answers to society's needs. Packaging the goods to be taught comes first, to the detriment of critical analysis of how knowledge and know-how should be imparted.

How should we rethink the problem of training engineers in the context of 'post-industrial' societies, characterized by the globalization of economies, an indisputable raising of the level of knowledge and the curiosity of young people and the increasing interdependence of the various productive forces? Can we come up with new training procedures that deliberately take account of our increasingly widespread access to information? Which partners, structures and networks of expertise could be used to bring about far-reaching change in our methods of training engineers?

2.5 Information as the heart of engineering training

Having regard to these differing approaches to engineering training, how information management is taught will depend on the choice of training model and on the cultural environment. The aims, curricula and teaching methods used in information training will be noticeably different according to whether we want to produce engineer-technicians, engineer-scientists or engineer-managers.

Moreover, several other aspects should be considered when drawing up an information management training programme. Generally speaking, it can also be said that training activities will differ according to the nature of their objectives, their place in the training curriculum and the particular student groups targeted. The content of the different forms of training will also vary considerably.

2.5.1 The ultimate aims of information management training

(a) **Consolidating engineering training.** From this point of view, information is regarded as an essential part of the learning process. It would therefore make sense to find, at the very least, a general course designed to develop awareness of information and documentation methodologies in all technical universities and engineering colleges. Such an introductory course intended for all students should be held during the early years of training and should enable the students to use to best advantage the information and documentation resources available to them at the university and in companies. An introduction to the handling of the tools for finding information in libraries and documentation centres should be part of this first objective.

(b) Equipping students to exercise their profession more efficiently. We should try to teach future engineers to work more efficiently by making them aware of the various methodologies available, such as value analysis, the quality approach and methods of competitiveness for companies - all methodologies in which information plays a vital role. This second objective is part of what is already a more specific approach to the engineer's work. It concerns primarily the introduction of training modules intended for students during or towards the end of their studies, and should lead to the development of learning processes dealing with the strategic management of information as part of the engineer's everyday work and as a specific methodological approach.

(c) Giving students two kinds of expertise. This third objective concerns those students and engineers who can add this particular ability (management of information processes) to their range of professional skills. In other words we should seek to train specialists in the strategic management of information so that they may acquire the dual expertise of 'engineer' on the one hand and 'information expert' on the other, using specific or optional courses. In this way we can train, for example, engineers specializing in the monitoring of technological developments, or in industrial property (patents).

2.5.2 The most appropriate periods for information management training

Another way of tackling information training is to consider all the appropriate periods of study and levels of training that might be involved.

(a) The start of the initial training period. This is of course the ideal time to introduce engineering students to the information and documentation resources available. Students must learn to handle some basic tools which they are bound to have to use both during their studies and in their careers. At this early stage, students are learning basic engineering sciences such as mathematics, physics and chemistry, and the rudiments of a specialized subject (continuum mechanics, signal theory). After leaving secondary school, students are confronted with a wide range of new knowledge to be discovered and explored.

This initial introduction to information and documentation should be regarded, then, as a time to learn the major landmarks in documentation: for instance, becoming familiar with the traditional tools for bibliographic searching, which covers large areas of scientific knowledge. But it is also the ideal time to adopt effective practices concerning information and documentation, such as learning how to decipher a bibliographic reference, reading journals and periodicals regularly and putting the right questions to information specialists.

(b) The end of the initial training course. Various experiments take place between the third and fifth years of the engineering training course, at a time when students are involved in individual and group projects or working on dissertations or theses for their diplomas. At this point in engineering studies, students are confronted with a more complex set of disciplines, combining basic scientific knowledge, technological developments and professional practices (the 'tricks of the trade'). They are also learning the practicalities of working for a company in the field, and finding out how closely the technical, economic and, at times, social aspects of the profession are dovetailed.

During this period more sophisticated methodological approaches are called for, based on more adavanced ways of seeking useful information, especially the consultation of specialized or professional data bases or data banks. At this point we should insist on the need to make critical

summaries of the documents and data collected and on the need for a transcisciplinary understanding of information. Information transfer and professional communication are also areas that should be emphasized. At this stage, training in information management lies at the heart of the problem-solving and project management procedures which are essential for the engineer.

(c) **Additional and postgraduate training.** There are of course other periods that should not be neglected. This is particularly true of additional training such as master of science degree courses and higher diploma work, research-based studies leading, for example, to the 'diplôme d'études approfondies' in France, and doctoral degree studies, all of which require students to use more specialized and, in some cases, more professional sources of information and documentation. They will have to turn to foreign or international data bases, use the documentation centres of professional organizations or companies, obtain documents from remote sources and compile material written in several languages. The narrowness of the themes they are working on in their studies or research means they have to learn more sophisticated methods of access to information and methods of observing and defending theories.

These supplementary forms of training often provide a good opportunity to bring in more specialized and specific information management training modules, such as alertness to technological or strategic developments (theory and practice) or an introduction to industrial patents and standardization.

(d) **Continuing and in-service training for engineers.** This last possibility is another interesting area for original experiments and may well become essential for engineers wishing to specialize in the field of information transfer processes in addition to their main area of expertise. In the case of continuing training, different types of information management courses may be considered depending on the stage the engineer's career has reached:

for those at the start of their careers;

for the 30-35 age-group: teaching practising engineers, for example, how to file patents, defend and protect their ideas and cope with industrial espionage. Being alert to technological developments is a particularly important theme for the continuing training of engineers in this age-group;

for the 50-55 age-group: making it easier for engineers approaching retirement to pass on their knowledge, thus ensuring that this general stock of expertise is preserved.

2.5.3 Possible content of information training courses

It is essential to point out here that the aim of the training courses suggested above is not to turn engineers into information experts, documentalists or librarians by teaching them the basic principles and professional practices concerning information processing techniques.

This particular form of training for engineers and engineering students is, rather, more sharply focused on their professional problems and course content will be concerned with questions such as the following:

how are engineers to define and formulate their individual information and documentation needs?

define and formulate the company's information needs?

estimate the cost of acquiring information and thus make more informed choices about information solutions or the best investment decisions?

obtain access to information through the many different, complex and scattered sources available?

sift the information obtained and evaluate it?

process the information obtained and assess its importance and relevance?

prepare consolidated reports on the basis of the material they have gathered?

manage the information produced or gathered?

set up their own systems of information and documentation management?

encourage others to generate relevant information within the company?

turn knowledge and know-how to advantage, file patents and impose standards?

distribute information and communicate effectively?

listen to what is going on around them?

make optimum use of data bases and data banks in order to remain alert to technological and strategic developments?

incorporate information and documentation into the design process (computer-assisted design, value analysis, etc.)?

link documentary information to decision-making processes and to certain specialized systems, such as geographical information systems?

build up operational systems for the strategic management of specialized information within the company?

This list is not exhaustive, and each training institution can of course decide on more specific course content according to its particular areas of expertise. The textile industry cannot be compared to the electronic components industry and does not have the same information needs as building or civil engineering firms.

2.5.4 A wide range of training approaches

Although a visit to the central library or documentation centre is the first and most widely used initiative students take, it should not form the basis of these information management courses. Experience has shown that we must go much further. Such training, whether it takes the form of introductory courses or more specialized further study, must be explicitly incorporated into the regular training of engineers. Teaching staff should constantly review their approach and bring in complementary course work to make their instruction more effective overall.

Courses can be provided to students for this purpose, and seminars organized. Provision must be made for individual course work and exercises and group projects devised. This training

should be so well incorporated into the syllabus that the inclusion in final theses and dissertations of an 'information management' component concerning the subject studied should be made compulsory. A close association should be formed between information specialists and lecturers in the scientific and technical disciplines. Finally, it is strongly recommended that the training provided should be evaluated and endorsed by means of credits.

3. TYPOLOGY OF POSSIBLE TRAINING PROGRAMMES

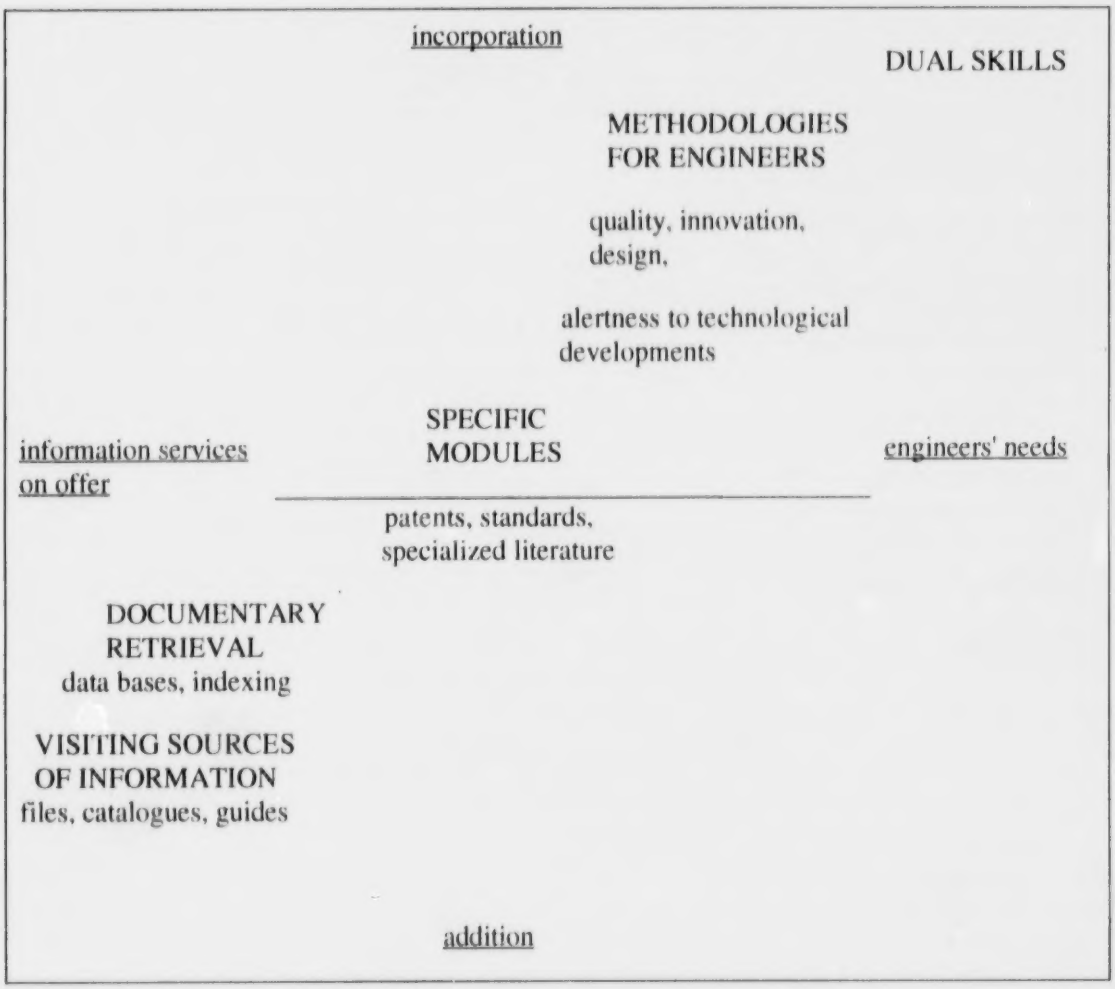
How, in practical terms, should an information management training programme or programmes for future engineers be organized? There is bound to be a very broad range of answers to this question, given the differences that can be seen in the lines of emphasis of the training provided for engineers. The only effective way of overcoming this difficulty is to make a comparative and critical survey of the projects or schemes that have been carried out in a number of countries.

3.1 The kinds of training currently available

On the basis of a compilation of such projects and experiments undertaken systematically from 1989 to 1991, we can attempt to form an overall view of the chief characteristics of existing forms of training and present, in succinct form, the various training possibilities on offer in the two-dimensional diagram set out below. In this diagram, the horizontal axis situates the origin of the basic concern or the training approach involved, the starting-points being either the services offered by the information professionals or the needs expressed by engineers and engineering students. The vertical axis shows the training method used and the extent to which information management studies are incorporated into the general course - from the optional and relatively marginal addition to the student's work (confined to a library visit) to the very close integration of the subject into the curriculum, in both disciplinary and methodological terms, with the use of innovative teaching methods.

The list of existing types of training clearly shows that they are situated, rather, along the diagonal lines of the diagram, even though some experiments deviate greatly from this pattern. From an initial examination, it can be observed that the types of training currently on offer range from informing students where and how documentation can be obtained on the campus, without any attempt to include the subject in the syllabus, to designing training modules leading to the award of credits, modules which involve the actual content of engineering studies and make full allowance for the incorporation of information management skills.

Apart from this strong 'diagonal' trend, we can point to some experiments with advanced types of training in the use of documentary tools offered by information specialists (such as computerized search methods for bibliographic references); these are, however, fairly far removed from the needs and concerns of future engineers. Mention may also be made of certain projects focused on engineers' specific information requirements (industrial property rights and patents, standardization and standards); unfortunately these are quite often only offered as optional courses and are not taken up by many students.



Types of information management training

3.2 The various kinds of information management training

A survey of the different kinds of training on offer shows that educational goals differ in their ambitiousness and that there is, more particularly, a varying degree of awareness of engineers' specific information needs.

3.2.1 Showing students where to find documentation and how to use documentation tools

This is the traditional task - usually described as library orientation - of many librarians of technical universities and schools of engineering. It involves familiarizing students with the layout of the library, its documentary resources, the expertise of the people who work there and the principal tools available.

These short introductory sessions, generally lasting between one and three hours, are intended for first-year students or those attending the university or college for the first time.

They obviously cater for large numbers of students and this can pose practical problems for those responsible for their organization.

They almost always include:

a brief theoretical introduction to what a library is and sometimes a general idea of the importance of information and documentation;

visits to libraries or documentation centres, with comments on the stocks, how to become a user and consult or borrow books and periodicals, opening hours etc.;

an introduction to the main tools used (files, catalogues, data bases) sometimes combined with limited exercises to test the students' ability to find certain documents on their own;

sometimes demonstrations on how to retrieve information from data bases, either on-line or on CD-ROM.

Students are often given documents, guides or manuals about the library or documentation centre, and sometimes audio-visual aids and courseware are used to make this introduction more attractive.

The 'library orientation' approach or the introduction to library resources is traditionally carried out by information specialists, sometimes at times set aside for the purpose but quite often only when the students have free time. These sessions provide an opportunity for students and information specialists to make contact and get to know one another.

This first step is very widespread in the universities of the English-speaking countries and northern and eastern Europe. Particularly good examples of this type of work are carried out in the Imperial College of Science, Technology and Medicine, London, and the Technical Universities of Helsinki, Göteborg-Chalmers, Eindhoven and Budapest, to name but a few. This initial action is appreciated to a lesser extent by students in south European countries, who often find such sessions out of keeping with their idea of their future profession and of limited interest compared to high-level scientific studies.

3.2.2 Training in information retrieval and practices

Over and above an introduction to the facilities offered by libraries and documentation centres, some establishments propose short seminars or meetings (over a period of one to three days) designed to help students in the use of bibliographic tools, the coding of documentary references and the assembling of data.

The practical aspects of these training modules include the use of specific cataloguing tools, an introduction to documentary sources in the relevant area and the interrogation of bibliographic data bases.

It should be pointed out that such courses are all the more appreciated by students inasmuch as they take place during the final phase of their studies and can be organized in connection with individual or group projects. The use of modern information technology such as on-line research, CD-ROMs, electronic document management, faxes, the ISDN network and electronic mail strengthens the students' motivation to take part in these training modules.

Paradoxically, it may also help them re-acquire a taste for manual retrieval methods which they might have regarded previously as tedious or outmoded.

It is highly desirable that such seminars on information retrieval should be included in the students' regular timetable. In some cases they may even lead to evaluation and the award of credits.

The organization of these training seminars is usually the responsibility of information specialists working for the establishment, with assistance in some cases from lecturers in scientific and technical disciplines.

Whereas these seminars are basically intended for students reaching the end of their training and working for their diploma, mention should also be made of their importance in postgraduate studies, more especially for the master of science degree, or, in France, the DEA (Diplôme d'Etudes Approfondies).

One pitfall to be avoided in this kind of training - especially in instruction in computerized information retrieval - concerns the overriding desire of the information specialist to explain the subtleties of 'documentary equations' and Boolean algebra to students with a scientific background who already have a firm grasp of the (,tual games made possible by the theory of sets and logical operators.

3.2.3 Training in specific aspects of information

More ambitious and original are the specific training modules leading to the award of full credits and designed to include in a study course the acquisition of a skill in all or part of an information management process for engineers. These modules, which are credited in the same way as mathematics, language or road design modules, already form part of a professional information management system of value to the engineer. In some cases they may seem to be the natural extension of traditional training in information retrieval, but they may also significantly diverge from it.

By way of example, mention may be made of the modules offered by the Conservatoire National des Arts et Métiers (Paris) on the acquisition, management, use and communication of scientific and technical information, or those on strategic information, standardization and industrial patents. The latter themes are the subject of particularly original training modules available to engineering students: patents, standards and certifications are basic sources of information and essential tools for defending individual and group interests.

Alertness to technological and strategic developments is also a theme that engineering students like to study by means of such modules, especially if they can handle some strategic tools (processing citations, cartography of bibliographic references) which enable them to find the active sources of knowledge and to follow the development of issues concerning research and innovation.

Information retrieval, whether manual or computerized, studied in the broader context of managing information sources for a given professional sector, can form the basis of original training modules that are firmly anchored in courses for the training of engineering specialists.

Specialized communication, scientific and technical drafting and efficient reading techniques are all themes that crop up in specific training modules.

These modules can represent from 20 to 50 hours of training, including a high proportion of individual work by the students (with credits). They may take place in one or several sequences and be spread over several levels of training.

Instruction is provided mainly by mixed teams of lecturers and information experts from the college or university and outside experts.

3.2.4 Incorporating information management training in disciplinary and methodological instruction

There is a fourth category of training activities that represents a more ambitious attempt to incorporate information management studies into existing classes or courses.

Information is accordingly seen as a fundamental element to be included in these courses; from the teaching standpoint, it can be incorporated quite naturally.

This may mean including it in disciplinary studies, such as courses on electronic components, agronomics or chemistry. This has been done at the Ecole Nationale des Ponts et Chaussées (Paris) with regard to study of materials; students undertake a considerable amount of individual work in information searching concerning the various points discussed in the class.

Information management studies can also be incorporated quite naturally into the management training provided to engineering students. Surely it is logical to include information resources management in the efficient management of company resources?

The prospects for including information management training in methodological instruction also look very promising. Indeed, it is obvious that the marshalling of pertinent information is an essential part of problem-solving procedures and of the creative process. Information management is central to decision-making methods, just as it is to work plans drawn up by value analysis groups or quality circles. When instruction is given on value analysis, it is frequent to see the students' serious concern about information processes within the company. Sometimes they even construct 'information models' about the company's products.

Information and documentation are also included in training on product generation, design, innovation and technology management. Surely it is during this very practical instruction that we can best encourage students to use data banks on materials and technologies, industrial catalogues and directories, analyse what rival firms are producing and examine patents, standards and designs?

Training in communication skills, now systematically included in engineering studies (an engineer is, for essentially professional reasons, a communicator), often provides an opportunity to broaden students' interest in the full range of information issues. Technical drafting, preparation of oral presentations, communication with the use of the media, the production and use of audio-visual media and command of the new communication technologies all provide opportunities for combined information and communication courses.

As the computer is now central to the work of all engineers, could we not devise original forms of training which, with the use of either microcomputers or mainframe systems, would be expanded to cover the real problems involved in specialized information management? What are the links and the logical relationship between word processing, computerized information retrieval, statistical processing of information, the setting up of individual and group data bases and data banks, electronic archiving, electronic document management, computer-assisted and CD-ROM-assisted instruction, simulation tools, computer-assisted design and manufacture, geographical information systems, decision support systems, machine translation and the language industry?

Training in information management processes ultimately finds an appropriate place in transdisciplinary or interdisciplinary studies. Information retrieval, processing, management and dissemination are all links in a chain of collective activities to which engineering students can be introduced and in which they can be trained. Obviously, these innovative and ambitious courses imply the involvement of a number of staff members in the establishment, and demand, first and foremost, close teamwork and rejection of disciplinary compartmentalization (the examples provided by the Ecole des Mines (Paris) provide ample proof of this). The courses are included in most of the timetables of students reaching the end of their studies or working for a doctorate and they are extremely popular with those attending them. They are, in fact, the sign of far-reaching changes in the way engineers are trained and should now be the subject of even closer observation.

3.2.5 Training for dual skills

This particular training possibility concerns graduate engineers or engineering students seeking to acquire skills of two kinds: proficiency in their chosen field of engineering and a certain professional level in information management. This kind of training is beginning to develop and in some cases could be said to rival traditional courses for information specialists. For instance, the Institut National Polytechnique de Lorraine (Nancy) is training students in two skills with the aim of helping companies to solve their information problems more effectively.

These courses, intended for students about to complete their engineering studies, enable them to direct their attention to information management methods. Students can thus be called on to deal with the engineering of a company's information system (establishing information flows concerning a large industrial plant, for instance).

Other postgraduate training leads to a second degree or diploma (master of science, DEA) in information management after a further year of study. This has the clear objective of enabling students to acquire dual proficiency after they have specialized in a certain branch of engineering. This type of training may seem to compete with traditional training courses for information systems managers.

3.2.6 Continuing training for practising engineers

We should not forget to include in our discussion continuing training courses for engineers already in employment. This has been a widespread concern among engineers' organizations and the holding of several world conferences to consider the question of continuing training is proof of the scale of current efforts to keep knowledge and know-how up to date.

The Conseil National des Ingénieurs et Scientifiques (French National Council of Engineers and Scientists) has recently started to compile, with official backing, an inventory of continuing training courses for engineers which are focused on information management. Projects like this are also under way in Indonesia, Finland and some central European countries, and there are plans for them in the Maghrib countries. Generally speaking there are not many such courses and those that do exist deal with traditional problem areas such as industrial patents, standardization and sometimes the use of specialized data bases and data banks. Technological development alertness and strategic monitoring are themes that are starting to appear in the syllabuses of continuing training bodies.

The syllabus offered by the Continuing Training Centre at the Helsinki University of Technology is, in several respects, a model that could be transferred to many other countries. In general, the training is provided either by specialists from technical universities or by experts from national engineers' organizations.

3.3 Information training and tomorrow's engineers

How is information going to change the working conditions of tomorrow's engineers? What is their occupational profile going to be?

These questions show that we cannot discuss the training of engineers in information management without raising the issue itself of how tomorrow's engineers should be trained.

The engineer of the twenty-first century will increasingly be faced with new ways of mustering and marshalling knowledge which will require skills in understanding increasingly complex circumstances. It is essential that information management courses for engineers should anticipate (or perhaps simply catch up with) certain developing trends.

3.3.1 The quality approach

The quality approach, nowadays a firm fixture in the way efficient companies work, is actually an ongoing process of information management. Quality control, quality circles, overall quality, reliability, safety of operation - they all call for the complete mobilization and efficient processing of information. The comparison and contrasting of information and documents from different sectors of the company or from the outside world, statistical analysis of available data, the legitimate means of expression of employees and value analysis are so many pieces in the 'specialized information' jigsaw that have to be fitted into the quality approach.

This is why the training of engineering students in information management may undergo far-reaching changes when its importance in the quality approach is realized.

3.3.2 Working methodologies

These methodologies, and particularly problem-solving and systems analysis methods are extensively used by competitive companies nowadays. Methods such as value analysis and creativity techniques have proved their worth and are indicative of the importance attached to teamwork or the idea of a work plan in problem-solving. All these methods have one factor in common: the essential mastery of information skills. Information is the key resource in these methodologies which seek greater efficiency.

The performance of a multidisciplinary working group depends on its ability to obtain, process and reformulate the information available in good time. There is a fundamental link between methodology and information, one that engineers are still not fully aware of but which training in strategic information management should reveal to them.

3.3.3 The engineering of information and knowledge

This new problem area is the third aspect of how the engineer's job is changing. Artificial intelligence and expert systems are now key words in an engineer's work. Whether placed downstream or upstream from the machine, the engineer needs more knowledge, more know-how, more brain-power and above all much more data. Access to data banks and data bases containing facts and the laws governing the relationship between these facts is essential. In this context, training in strategic information management is perfectly compatible with a new engineering of information and knowledge, which in one way or another brings us back to the decision-making process.

3.3.4 The multiplicity of cultures and their cross-fertilization

The globalization of economies, the opening up of frontiers and the free flow of people and goods have introduced a new factor that must be taken into consideration in any engineering training plans. Those responsible for this training have for several years now made it compulsory for their students to learn foreign languages. Similarly, knowledge of international marketing data is becoming indispensable. The design, manufacture and marketing of industrial goods of all kinds calls for the involvement of people and institutions worldwide; this means that the engineer must know how to work with people of different cultures and speaking different languages.

For engineers, strategic information management means handling the relationship between these different cultures and languages as effectively as possible. It also means taking account of the need to manage trans-frontiers data flows efficiently and to work in a world context, while remembering that individuals and society as a whole express their needs first and foremost at the level of their home environment.

4. RECOMMENDATIONS ON ACTION TO BE TAKEN

In order to ensure the success of information management courses in higher education establishments responsible for training engineers, several conditions must be fulfilled. These include the drawing up of a clear policy on the subject, consideration of the general context of these training activities in relation to the objectives of engineering studies and ensuring that they take place at the correct stage in those studies. Similarly, there are conditions governing the educational facilities to be made available, the teaching staff involved or the use of new technologies. Finally, if we extend the scope of the problem being considered, there are a number of general measures - at local, national and international level - that should be introduced if these new approaches are to have the best possible chance of success for they are still difficult to implement in everyday practice and are often regarded as a side issue by those in charge of engineering training.

The following recommendations were made by some 15 specialists consulted in 1990 and 1991 or are derived from suggestions put forward at various international seminars, including more especially the expert meeting on training information users in higher education organized by UNISIST at Espoo, Finland, in August 1990.

4.1 Main guidelines

(a) Information management should be regarded as an integral and fundamental part of higher education in technology and engineering.

(b) Students must be aware that obtaining an engineering qualification is no more than the start of a career and that they must pursue their education by attending continuing training seminars and lectures. They should also continue to seek out new information and keep their knowledge up to date on a permanent basis.

(c) All engineering students should be obliged, during their study course, to follow training which will equip them to manage information flows effectively, as well as enabling them to solve problems and to keep their knowledge constantly up to date.

(d) Training in information management should involve all members of higher technical establishments or colleges of engineering and should take into account the particular needs of each group (students, lecturers, researchers, administrative staff).

4.2 Respecting specific characteristics

(a) Training in information management should take account of the specific character of each country, each disciplinary context and each engineering college.

(b) Courses in information management should be devised in the light of the particular features of engineering studies and the intrinsic value of information to engineers. Persuading students to use libraries as an end in itself should not be their sole objective; they should make the students aware of the importance and potential of a thorough grasp of information processes.

4.3 Objectives to be achieved

(a) Engineering students must recognize the vital role of specialized information in modern society and its impact on technical and social innovation, the thrust of research, the evolution of technical methods and industrial development. They must also grasp the importance of the various types of data - words, facts and figures - and the increasingly strong informational links between science, engineering and technology.

(b) Students must know how to explore the specialized information system designed for engineers and understand the role of the various information sources within this system. They should be able to set out a problem correctly, obtain relevant information and present their findings in an effective way. They should also know how to make the best use of libraries and other documentary resources, especially computerized information retrieval systems.

(c) Students should be introduced to procedures that ensure that engineers remain alert to developments in information, technology and strategies, and through thorough understanding and use of the best information resources, given the stimulus to invest and innovate.

(d) Engineering students should be capable of finding things out for themselves, by working both independently and in groups, a process which will give them better training in working methods. As the principal aspect of an engineer's training should be methodological, students must be encouraged to use the most diverse and effective heuristic processes in seeking information. Similarly, they should be encouraged to discover different environments (the company, other cultures and other disciplines). Communication in all its forms (spoken, written, audio-visual or by means of integrated computer/telecommunication systems), the dynamics of mixed groups, and language proficiency are all components in the active learning methodology of obtaining and using information.

(e) Students should acquire outlooks and skills that will be of value to them throughout their careers, especially decision-making and problem-solving skills and, above all, the desire to continue to learn.

4.4 Levels of training

There should be at least *three levels* in the provision of training in information management.

(a) During their first year at a technical university, and if possible right from the start, engineering students should be taught to use the university library and its tools, to look for references and find works and documents.

(b) Later, towards the middle or at the end of the study course, forms of training should be devised leading to a qualification in specialized information resources management and methods of storing information useful to students in their individual work: carrying out of documentary research or searching for information in a specialized area of study, preparation of bibliographies and abstracts, introduction to specific aspects of information used by engineers (standards, patents, technical and commercial material) and to current awareness information.

(c) After obtaining their qualification or during postgraduate or doctoral studies, students should receive training in more sophisticated forms of information retrieval using the most efficient sources and technologies and learn how to generate and pass on specialized knowledge, draft scientific and technical material and prepare technical documents for engineers.

4.5 Content of training programmes

(a) Training should encourage a comprehensive approach to information management by seeking as far as possible to co-ordinate all aspects of specialized information and communication, ranging from relevant information retrieval to the processing of information and documentation and the preparation of consolidated reports, and including the different forms of oral, written or visual communication or, again, foreign language proficiency.

(b) Training should contain various modules introducing students to specialized information management: technological search methodology, scientific and technical drafting, specialized publications and so on. These modules could include lectures and practical instruction on using libraries and information services. Students should be required to do individual work, especially in regard to documentary retrieval and the preparation of abstracts and reports.

(c) Engineering students should be given a wide range of exercises dealing with information retrieval on various subjects, the preparation of abstracts covering scientific and technical publications, technical and commercial material and technical projects, the drawing up of synoptic and state-of-the-art reports, and the setting out of information of value in decision-making.

(d) One important aspect should be training in computer science procedures of relevance to engineers and, more especially, the dynamics of information systems, statistical and probabilist techniques applied to information, and social science methods such as content analysis.

(e) Students should also acquire a sufficient grasp of information systems, emphasis being placed on the systemic approach, the definition of analysis levels, understanding and determination of information needs, evaluation of the services offered by professionals and the cost of obtaining information.

(f) Finally, students should learn to recognize the new role played by computers and clearly to distinguish the different systems used by information processing machines (information technology). The importance of coding information and managing information systems should also be stressed (file management, archiving of data, organization of access to information and use of telecommunication tools and networks).

4.6 The relevant teaching methods

(a) Every effort should be made to build up and combine investigative methods, to explore all the documentary techniques available, and to make use of as wide a range of information services, industrial partners and engineers as possible.

(b) Training should not be concentrated on approaches that are too mechanistic or that involve too much manipulation of documentation. Instead, practical activities should be devised that are typical of the work of engineers seeking to obtain information.

(c) Students should be motivated by having to work on topics related to real problems, especially subjects that they are to deal with as part of their studies.

(d) The training should emphasize learning activities in which the students play an active part, making maximum use of their actual experience, their individual projects and the training periods they may have spent in industry.

(e) As far as possible, students should work in teams rather than on their own in order to gain time, reduce the risk of error and, more especially, develop creativity. There is no incompatibility between teamwork of this nature and the aim of ensuring that students acquire independence in seeking information.

(f) Students' capacity for wonder, curiosity and discovery should be developed, while exercises of a highly deductive type (such as the searching of files by logical methods) should be accompanied by work that encourages inductive creativity (such as discovering new sources and inventing appropriate information management procedures).

(g) Assessment of the students' work is essential; they should be required to prepare consolidated reports and make oral presentations concerning the subjects studied.

4.7 Incorporating information into training

(a) Training in information management should be gradually and thoroughly phased into the course of studies, and should be appropriate to their level and general thrust.

(b) The training provided should be directly linked to the engineering students' regular syllabus so as to increase their motivation; it should form an integral part of the course, and be the subject of an assessment which is taken into account in the award of degrees or diplomas.

4.8 Using new technologies

(a) Information management training in higher education of a technological kind should take fully into account the progress made by information and communication technologies so that engineering students may make the best possible use of the information resources and services available both within and outside their place of study.

(b) Engineering students should be encouraged to use the best information facilities available today and the most efficient information technologies and services; they should be familiarized with these new approaches, even if these activities involve considerable outlay.

4.9 The people and institutions involved in information management training

(a) Mixed teaching teams should be brought together, consisting of information specialists, lecturers in engineering disciplines, engineers and persons of note from outside the university, the aim being to encourage contributions that will throw light on specific areas, and

to compare and contrast differing points of view. Engineering students should benefit from the greatest possible co-operation between the teaching staff and the documentation centre or library.

(b) Information management training should be regarded as a basic task for information professionals such as librarians, information specialists, documentalists and archivists working in the higher education establishments, technical universities and engineering colleges concerned.

(c) Specific teaching units, such as university chairs, might possibly be set up with responsibility for devising, implementing and developing information management training programmes and producing the appropriate teaching aids.

4.10 The facilities required

(a) The technical university or engineering college must be equipped with a sound documentary infrastructure, genuine professional skills and sufficient technical resources, all in keeping with the type of establishment involved, for every aspect of access to specialized information and documentation.

(b) It must have a minimum budget for data base searching, access to documentation outside the establishment and the acquisition of documents of value in the training of engineering students.

(c) Practical guides, training modules and teaching materials should be devised and made available to students in different forms (computer-assisted teaching modules, videograms and publications). In particular, teachers and researchers at schools of engineering should be encouraged to produce information and training materials that can easily be transferred or exchanged, or used to supply case banks and educational data bases.

(d) Workstations for self-learning purposes should be designed for engineering students, making it easier for them to obtain, process and disseminate information. Work to this effect should be carried out in conjunction with industrial partners with the aim of devising intelligent self-training work stations that include various information management tools and can be used by students throughout their studies. This will allow them, after obtaining their engineering qualification, to retain most of the stock of information they have gathered and bring it up to date in the course of their careers.

4.11 Structures that must be devised

(a) An environment must be provided which will stimulate engineering students' awareness of current developments in information and technology and encourage them to come up with their own ideas. Technological parks, situated on the outskirts of technical universities and engineering colleges, can enable useful contacts to be made in this respect with leading industries.

(b) Information and educational resource systems or centres of a polytechnic kind should be set up at the regional level or in large cities. These large-scale facilities, representing a new type of university library, a real mechanism for the provision of information of a structural kind, could be consulted by students from a variety of backgrounds, either on the

spot or by remote access; they would facilitate individual or collective access to information and knowledge, the comparison of sources of knowledge, ensure the monitoring of the knowledge acquired and help students to develop individual tools for managing their own stock of information.

4.12 Steps to be followed

(a) The work of developing students' awareness and knowledge of information management should take the form of a long-term project, i.e. implemented throughout their study course on the basis of pluriannual programmes. Training should be built up throughout the entire course of study through a coherent set of complementary approaches to information.

(b) There should be no hesitation in introducing measures which will act as an incentive and serve as examples in order to transform structures and change ways of thinking.

(c) Alongside high-profile measures, long-term structural projects should be carried out in order to increase the effectiveness and success of programmes.

(d) Training programmes that have won acclaim should be highlighted, experiments that have proved their worth should be publicized, and successful strategies promoted so that the support of as many partners as possible may be secured.

4.13 Other supporting measures

(a) Secondary-school pupils should be made aware of elementary information and documentation procedures very early on and before they go to university.

(b) The students' level of knowledge of documentation and information methodologies should be checked when they are admitted to university or during the recruitment, possibly by entrance tests to determine their proficiency in obtaining and processing information.

(c) Suitable training should be provided for information professionals, in the form of both pre- and in-service training, so that they may assume their responsibilities in full as trainers at the technical universities or engineering colleges where they work.

4.14 National and international organizations

(a) Intergovernmental and non-governmental organizations should promote information management training in higher education, and especially in engineering colleges and technical universities, at national, regional and international level.

(b) National and international programmes should be introduced to develop new approaches to the training of engineers and information management. National and international government programmes (at the European level, for example) for aiding the development of new systems for the transfer of knowledge are essential. These specific programmes should encourage the emergence of types of training based first and foremost on modern methods of information management.

(c) The compilation and comparative study of experiments in training engineering students in specialized information management should be continued at both national and

international level. The dissemination of studies on this subject should be promoted and the pooling of know-how among the various higher professional education sectors should be encouraged.

PART TWO

Examples, experiences and personal accounts as a basis for devising and setting up information management training schemes

1. GENERAL INTRODUCTORY PROGRAMMES

Most libraries at the major technical universities regularly offer students in engineering departments or faculties a variety of introductory and training courses in using the information resources available on the campus.

1.1 Introduction to the use of the library and documentation resources at the Twente University of Technology, Netherlands

Type of course

Introducing engineering students to the opportunities offered by the library by means of lectures and exercises.

Description

The Education and Information Technology Library at the Twente University of Technology offers lectures and exercises to students in the science and technology faculties with the aim of familiarizing them with the different information facilities available. These introductory sessions range from two-and-a-half to eight hours, depending on the faculty, and are provided at different training levels (over a four-year period). The courses are compulsory in some cases.

The subjects dealt with include the use of on-line public access catalogues, searching for documents on the bookshelves, the use of bibliographies, information retrieval strategies, the preparation of bibliographic references or records and sometimes the drafting of reports, and the organization and rules of the University of Twente Library.

(J. BRAAKSMA, Twente, Netherlands)

1.2 Introductory and training courses in the use of information and documentation for students at technical universities in Poland

Context

Various technical universities in Poland.

Federation of Polish Engineers and Technicians (NOT).

Type of course

Courses at several levels designed to give engineering students a sound knowledge of information and documentation sources and facilities.

Description

Several technical universities in Poland (such as Warsaw Polytechnic College, the Technical University of Silesia, the Technical University of Szczecin and the Academy of Mining and Metallurgy) have, with the help of engineers from the Federation of Polish Engineers and Technicians (NOT), set up a number of training courses for their students in specialized information management. They include:

(a) Short modules lasting about four hours to introduce first-year students to the documentation services and tools available.

(b) During the third and fourth years of study, a specific course or credit that may take up two hours a week, including theoretical lectures and hands-on exercises. This course focuses on information sources and methods that are regarded as essential for engineers and is also intended to help students prepare their final diploma work.

(c) More specific training is available for students who have just obtained their qualification or are studying for doctorates.

These courses comply with recommendations made by the Ministry of Education but the individual universities are given a free hand in organizing them. Considerable importance is attached to industrial information and documentation, such as the appropriate use of technical and commercial documents, standards and patents, and technical documents concerning engineering projects.

(W. PIROG, J. METERA, Warsaw, Poland)

1.3 Training programme for students at Tampere University of Technology, Finland, in the use of libraries and other specialized information resources

Type of course

A complete training programme in information retrieval and management for engineers, including specialized courses and seminars.

Description

In Finland, training library users is regarded as essential in all technical university libraries. Compared with other universities, the courses and training provided by technical universities are more formal and are generally compulsory (credits are given). A variety of teaching methods are used, such as tours of the library, lectures and personal service. Specific documentation and locally produced teaching materials are also used in many libraries.

At the Tampere University of Technology, Finland's second largest university of technology with 4,900 students and 450 teaching staff, the library - originally the scientific and technical library of the City of Tampere - has, from the outset, been very active in on-line information searching and special staff with a formal background in technological subjects have been employed for these purposes; in 1991 they represented about a quarter of the library staff. The duties of information specialists also include training students in the use of the library, its facilities and services.

This training is provided by the library at various levels.

First-year students are taught to use the library during a compulsory introductory course in the first month of their studies. On-line searching of the library's own data bases and, for instance, the searching of CD-ROM data bases, is carried out in afternoon seminars.

Training for students at postgraduate level is focused on more sophisticated methods of information retrieval. It is incorporated in the students' individual work in searching for information relevant to their theses. Information specialists provide an individual reference service, backed by the use of modern information access techniques.

Voluntary formal courses are also offered.

One is a 12-hour course on information management which counts as half a week towards a credit and deals with the use of information in technology and engineering research, information search techniques, manual and on-line information sources and personal information management. Exercises and group work on this course include manual and on-line searching techniques, location of primary documents including inter-library practices, and the creation of personal data bases.

Students are also offered a seminar in information retrieval lasting a day and a half. The first morning is spent searching for information, using both manual and computerized methods, and relevant information sources. This is followed in the afternoon by an exercise in literature searching based on a real problem. The final half-day session, two weeks later, is devoted to evaluating the search results and the acquisition of documents.

More specialized seminars are also offered, usually lasting a half-day and aimed at giving a general review of information activities in specific fields, such as occupational health and water engineering. Students are given practical demonstrations concerning the use of certain information facilities.

(Arja-Riitta HAARALA, Tampere, Finland)

1.4 Introductory training programme for students at Eindhoven Technical University, Netherlands, in the use of library and information resources

Type of course

This programme is offered at several levels, and consists of an introduction to using the library, information sources and services, an introduction to documentary retrieval and an advanced course for postgraduates.

Description

The Eindhoven Technical University Library offers an introductory programme at three levels.

(a) For first-year students, there is a two-hour initial session with a description of the library as an institution, followed by a guided tour of the premises and finally a standard session (using questionnaires) on searching the VUBIS integrated computerized catalogue.

(b) A further three hours' training is then offered to more advanced students. This deals with systematic information retrieval and includes a refresher session on access to information resources, stressing the wide range of bibliographies available, an introduction to the system of scientific knowledge, methods of supplying information (problems of selecting and compressing data), and an introduction to use of major data bases available on CD-ROM. The aim of this training is to enable students to search for material for their theses.

(c) A third level is available for postgraduates in the form of a one or two-day course entitled 'Information retrieval methodology'. It develops the following subjects: the system of scientific knowledge, documentary information system, the role of the university library and of the researcher in these two systems, methods of collecting, processing and distributing documentary information, methodology for documentary retrieval, training in the use of data bases on CD-ROM such as Compendex, Science Citation Index, Perinorm, Dissertation Abstracts, NTIS, ERIC, ABI-Inform.

(P. van BRUJTENEN, Eindhoven, Netherlands)

1.5 Training programme for students at Chalmers University of Technology, Göteborg, Sweden, in the effective use of libraries and specialized information resources and services

Type of course

A full user education programme in information resources and services, with emphasis on specific courses and seminars.

Description

Chalmers University of Technology (Göteborg) is a European University of Technology founded in 1829. Currently there are some 4,000 students studying for master's degrees in engineering (a five-year course) and about 800 research students working for higher degrees in seven colleges of engineering. Studies are organized in intensive discipline-oriented courses supported by laboratory work. There is a growing emphasis, however, on training in problem-solving.

Library user education courses for engineering undergraduates were introduced in the mid-1970s and the programme was extended in the early 1980s to include courses for students for higher degrees and external users.

In 1991 the programme consisted of four stages. It is fairly typical of what is being done in north European countries.

(a) An introduction to the use of the library and its tools

This course is intended for new users and especially first-year students. It takes about two hours, includes a lecture and individual exercises, and is attended by some 900 participants each year.

(b) Introductory courses in information retrieval methods

These compulsory 15- to 20-hour courses are designed for third- and fourth-year engineering students (some 800 students). They include an introduction to scientific communication and to different types of information retrieval. This is followed by 'laboratory' sessions devoted to manual and computerized information retrieval in connection with project work or the master's thesis.

The courses are given to students with a homogeneous background, such as those studying chemical engineering or industrial economics, which facilitates the use of specific

tools (data bases in the subject field). Each student has to prepare and carry out a short on-line search (about 15 minutes).

(c) Advanced courses in information retrieval

Five semi-compulsory 70-hour advanced courses are offered to groups of 15 postgraduate (Ph.D.) participants. They include such topics as the information needs of research workers, scientific communication, the theory and practice of citation indexing, computerized information retrieval, the use of CD-ROM data bases, methods for primary document supply, personal data bases, patents as a source of information and electronic mail. Guest lecturers present specialized topics.

For these advanced courses, students are required to carry out an in-depth on-line information retrieval operation.

(d) Courses for external users

These cover various aspects of information handling. They are tailored to meet the specific needs of clients, and vary in length from a half-day to four days. Examples of clients are practising engineers, information specialists and students from other universities. These courses are charged for at appropriate commercial rates.

(e) Remarks

The courses offered by the Chalmers University library are paid for by the engineering departments, providing resources for a group of information specialists to engage in this specific educational work, and for the acquisition of computer resources. There is now good teaching accommodation - seminar rooms - and computer equipment available for the courses.

The importance of student motivation is emphasized in the timing of the constituent parts of the programme, and widespread use is made of modern information technology.

(Nancy FJÄLLBRANT, Chalmers University, Göteborg, Sweden)

1.6 Information studies for engineering students at Napier Polytechnic, Edinburgh, Scotland

Type of course

A comprehensive set of introductory and training courses in information and document retrieval for engineering students.

Description

(a) Objectives of the training programme

Napier Polytechnic of Edinburgh offers information studies to its students for two main reasons:

to help them become more efficient and effective in their studies;

to give them the skills they will need throughout their careers.

Napier Polytechnic Library has offered courses in information studies since 1970. Over this period, these courses have sought to develop beyond the mechanistic use of libraries and to include manual and computerized information retrieval, processing and management techniques.

The four objectives assigned to the courses are:

to make use of the libraries more efficiently;

to explore the structure and modes of information and communication used by the professional engineer;

to demonstrate the problem-solving capacities of information sources;

to develop practical information retrieval and processing skills using both manual and computerized methods.

(b) Components of the training programme

Three types of programme or training models are offered, depending upon student needs and the time available:

Model 1: Using the library

A two- to four-hour course introducing library services, explaining catalogues, indexes and classification, and presenting major reference sources.

Model 2: Subject bibliography

A ten- to twenty-hour course supplements the presentation of information sources for the engineer and explores the technical communication model of engineering as a discipline. Students learn about British standards specification and patents and study specialized journal articles. The main teaching methods are lectures, discussions, demonstrations and practical exercises.

Model 3: Bibliographic projects

A ten- to twenty four-hour practical course enables students to discover how to research a problem in the literature and write a report on their findings. This replaces the traditional exercises of the subject bibliography programme. The topics for investigation are set by the engineering faculties or departments and the reports are jointly assessed by a librarian (for the quality of the literature search) and by an engineer (for technical accuracy).

(c) Evaluation of the courses

Napier Polytechnic runs courses of this nature in all disciplines. The library has fully accepted the idea of training engineering students in information management. It pursues a direct teaching approach so as to bring librarians into close contact with students and to foster links between librarians and the teaching departments.

The principal advantages of the programme are as follows:

it develops a more efficient student, better able to work alone and solve problems;

it develops information management skills for the student's professional career;

it promotes the case of costly library resources, thus improving return on investments;

it promotes strong links between librarians and teachers, thereby improving the overall efficiency of the Polytechnic.

At present, the principal disadvantages are:

the heavy demands on library staff time;

the once-only effect of 'live' classroom work, with no long-term reusable product;

the limitation of the course to those students formally timetabled to receive it. (Most part-time students are omitted, yet part-time education is growing in popularity);

the fact that classroom emphasis is at odds with trends towards student-based learning;

the fact that library staff have been hindered from developing alternative information skills media (video and computer-assisted learning ...).

(David A. CUMMING, Edinburgh, Scotland)

2. COURSE SYLLABUSES AND EXERCISES

In some technical universities or engineering colleges, those in charge of central or department libraries have developed introductory courses on information and devised batteries of exercises with the aim of giving students a better understanding of how to find relevant information.

2.1 Outline of a course covering information sources in a given engineering field (example)

SOURCES OF INFORMATION IN ... (CIVIL ENGINEERING) ...

(a) Structure and characteristics of the field as they may affect information transfer.

(b) Information needs of engineers and other specialists in the field.

(c) Information-seeking behaviour (engineers in the field concerned).

(d) Different information flows:

informal: invisible college, informers, ... ;

formal and semi-formal: conferences in the field, professional associations ... .

(e) Barriers to effective information transfer:

language barrier;

inter-group communication.

(f) Information sources:

printed (works, journals, other sources ...);

electronic (data bases and banks);

other forms appropriate to the field;

specialized information centres in the field and the services they provide.

(g) Search strategy:

how to exploit information resources;

selection of an information source;

preparing a good 'request': transforming an information need into a search strategy;

consulting a data base: their characteristics;

approaches to indexing; abstracts; vocabularies used; thesauri, etc.

(h) Search strategy per se:

Boolean strategies;

natural language approaches.

(F.W. LANCASTER, United States)

2.2 Guided work in reviewing literature for third-year university students in agronomics

This guided study project requires students to prepare a review of literature on the national agricultural system or any other specific agricultural system, using documents available in their domain of activity (engineering college, institute, research centre, library, personal contacts, etc.).

Students are asked to restrict themselves to accessible scientific literature for consultation.

They are also asked to make reference cards on the documents consulted, noting the following data:

name(s) of author(s);

title of document;

source;

place and date of publication, name of publisher;

description or key words;

site;

comments.

From this collection of literature the students must then extract the basic characteristics of the agricultural system or systems studied and present a summary in the form of a comparative table of these different systems.

(Géoffrey PADONOU, Cotonou, Benin)

2.3 Examples of exercises for students attending courses organized by the Napier Polytechnic Library Service Unit, Edinburgh

Information Retrieval Course

(a) Questions from the information retrieval exercise (civil engineering)

Who invented shield tunnelling and when?

Where was Thomas Telford born? Which of his bridges was begun in 1819?

What is the address of the Institution of Highway Engineers?

What is the meaning of the German word 'Förderband?

And so on (about 20 similar questions).

(b) Questions from the catalogues exercise

In which library is the book 'Electronic transmission technology: line waves and antennas' held?

What is the accession number of the 'Product engineering design manual' edited by D. Greenwood and published in 1959?

L.T.R. Rolt wrote a book in 1962 and that book is held by Napier College Library. What is the title of the book?

Are any books classified at 624.13? If so, have multiple copies been bought of any title? Give that title and state whether all the copies are kept at the same site?

And so on (about 20 similar questions).

(c) Questions from the indexing journals exercise

Use the monthly part of Current Technology Index, July 1988, to find and record the full reference to any recent article on hydroelectric power stations.

Use the annual index of International Civil Engineering abstracts 1987 to discover and record the abstract numbers of any articles on water tunnels published that year. Give the reference of the first article.

In Cement Technology Index 1986, discover and record the exact heading under which can be found a reference to quenched iron.

And so on (about 30 similar questions).

(d) Questions from the standards exercise

Approximately how many new standards are published each year? What percentage of the total number of British Standards are new each year?

Use the BSI News for March 1988 to discover and record the titles of these new ISO standards - ISO5597:1987 and ISO6922:1987.

List the committees responsible for the preparation of BS2790, and indicate the principal type of illustrative factual material contained in Appendix C.

And so on (about 30 similar questions).

(David A. CUMMING, Edinburgh, Scotland)

2.4 Inductive teaching method, consisting of case-studies, analysis of search strategies and exercises for students at Coventry (Lanchester) Polytechnic

Type of course

A course for engineering students on information and library use, with case-studies, analysis of search strategies, practical exercises (inductive learning) and multiple-choice tests.

Description

(a) The course itself

The three-hour course initially emphasizes the information sources available in the engineering students' particular field of studies, such as automated production technology and robotics. A case-study on robotics, analysis of information search strategies and the accompanying exercises are then introduced during discussions. The final hour is devoted to carrying out these exercises.

At a one-hour session held a week later, students are given a test, with multiple-choice questions. Marks are awarded.

Before the initial session, students are expected to have consulted:

the basic guide on the library and its services;

the exercise sheets, with their answers;

the guide to information sources on automated production technology;

the guide to information sources on robotics.

(b) Case-studies

A short document (about six pages) is given to students before the course. It summarizes the work required and describes a problem faced by a professional engineer in the course of his work: 'A workshop in a metallurgy company, where a new, more expensive, but more efficient press has been installed. Excessive noise levels of between 95 and 100 decibels have resulted, and an increasingly hostile work-force blames the engineer for not anticipating this problem. What can be done? What should the workers be told? What suggestions should be made to the management? Several lines of information research are proposed: some dealing with noise levels and their effects on people, some with the legal and psychological aspects, some on noise measurement and noise reduction techniques.

About ten sources of information are mentioned. For each one, a question (inductive method) is asked that raises issues of information handling. For example:

Source of information: British Technology Index. Annual table for 1977. Abstracts and index section. Second floor.

Question: Give the name of the journal containing an article entitled 'Materials and methods for noise reduction' written by M.L. Booth in 1976.

The answers are given at the end of the document.

(c) Analysis of search strategies

A one-page document comments on the search strategies used to solve the information problem raised in the case-study. According to the type of information required, students are guided towards bibliographies, professional rules and standards, encyclopaedias and manuals, reference or abstract services and software directories (automated production technology).

(d) Accompanying exercises

Students are given a set of about ten exercises at the end of the course. During the session, they are asked to note, for each exercise, their search strategy, the type of information involved and all the problems encountered. A typical exercise might be:

Source of information: Hunt, V. Daniel. *Industrial robotics handbook*. New York, Industrial Press, 1983. 629.892 IND. Folio. Second floor.

Question: Find the part of this book that deals with safety. According to the author, what is the best protection against software failures?

(e) The information management test

A test made up of 25 multiple-choice questions is given one week after the session. Each question has four possible answers.

For example:

In which document would you find a short definition of the term 'industrial robot"?

Engineering index.

TVER and BOLZ - Robotics source book and dictionary.

Machinery handbook.

Kempe's engineering directory.

Evaluation of the method

The originality of this method can be summed up in the following points:

a case-study in information use, clearly based on a real situation in the engineer's work;

inclusion of the study in an active learning process;

a sequence on analysis of information search strategies linked to the information needs defined in the problem;

exercises (inductive method) in support of this analysis;

phasing of these various stages into an overall programme, the student being provided in advance with the materials to be studied, appropriate lectures being given on information sources and techniques, and multiple-choice questions being devised to find out how much students have understood.

(D.T. DAVIES, Lanchester, United Kingdom)

3. INFORMATION TOOLS AND TRAINING AIDS

Written documents are usually given to students to help them gain rapid access to the basic resources of their particular field of study. Such documents act as both information tools and educational aids.

3.1 Guide for engineering students to the resources of the library of Western Australia University

This guide, entitled 'Engineering information: a guide to sources' gives in six sheets (ten pages of text) the principal ways in which engineering students can gain access to relevant information sources and especially the library's bibliographic resources.

The guide is centred on the question 'How can I find documents in the library?'. It deals with catalogues, searching for books by subject, searching for bibliographic references, finding articles in recent journals, using indexes and abstracts (for different fields of engineering), sources of grey literature, computerized information systems, standards, theses, other libraries that can be used and guides for the drafting of scientific and technical documents.

Several references are given under each heading, providing full and extensive guidance for users' research.

(Diana SCOTT, Nedlands, Australia)

3.2 Guide to reference sources in science and technology at the University of Limerick, Ireland

This nine-page document, prepared specially for engineering students at the Technical University of Limerick, is called 'Abstracts and Indexes: how to search for journal literature on your science/technology topic'. It describes the various bibliographic orientation tools and ways of using these secondary sources of information (indexes and abstracts).

An introductory page explains what these secondary sources are (abstract journals for instance), while the following page gives several types of bibliographic reference. The rest of the document lists, in table form, the various sources of value to engineers (mentioning their accession numbers and the period of their availability in the library). The areas covered by each source are indicated as are the ways of using it (subject indexes, author index, annual table, etc.).

(Patricia O'DONNELL, Limerick, Ireland)

3.3 Guide to documentary sources at the Cranfield Institute of Technology Library (United Kingdom)

The Cranfield Institute of Technology Library has produced a series of simple, practical guides for engineering students about various specialized information sources. Each of these guides, from one to three pages long, is printed on different coloured paper. They cover:

AGARD publications (aeronautical research);

robotics literature;

documents published by the American Institute of Aeronautics and Astronautics (AIAA);

tables of ESDU data (information on aerodynamics for designers);

technical indexes series (on microfilm);

literature on polymers and composites;

patents;

documents published by the American Society of Mechanical Engineers (ASME);

documents published by the Society of Automotive Engineers (SAE);

literature on biotechnologies;

classification and siting of books in the library.

Each guide opens with an introduction to the area covered or the organization that publishes the relevant documents. Ways of processing and/or classifying documents are given next, along with a short description of how to gain access to these specialized information sources.

(John BLAGDEN, Cranfield, United Kingdom)

3.4 Guide to technical standards and specifications at the Noble Science and Engineering Library, Arizona State University, United States

This document is an example of the guides produced by the Daniel E. Noble Science and Engineering Library of Arizona State University. They set out to explain certain aspects of the campus library collections, both to engineering students and to engineers outside the university.

'Standards and Specifications in Noble Library' is a document consisting of four sheets (eight pages of text) and includes the following sections:

a general introduction to the production of standards and specifications in the United States and to the university libraries where they can be consulted;

how to find a standard: useful sources;

acronyms of standards organizations: more than 100 are listed;

non-military standards: 27 major categories of standards are listed in consolidated form;

a selection of information sources on standardization work is given (including three specialized journals).

This guide, prepared in January 1990, is a very detailed document, yet still pleasant to consult. It may be regarded as an information and educational aid for students at a technical university.

(Frances NEW, Tempe, Arizona, United States)

3.5 Guides for data base users at Helsinki University of Technology Library, Finland

Various documents have been produced and published by the Helsinki University of Technology Library to simplify access by engineering students to data bases and data banks.

These guides are very concise, accurate and pleasant to use:

a card measuring 20 x 8 cm lists on one side the data bases that can be consulted and how to access them; on the back it summarizes the main instructions of the command language, with examples;

a brochure composed of two folded A4 pages (six pages of text) gives all the practical instructions needed to access NORDRES system data bases on research centres in Scandinavian countries.

(Elin TÖRNUDD, Espoo, Finland)

3.6 Guide to information retrieval at the Université de Technologie, Compiègne, France

This document, produced by the library at the Compiègne University of Technology, is distributed to engineering students to help them carry out their information and documentation searching successfully, especially regarding product generation and setting up companies.

It is relatively small (six pages) and includes the following sections:

1. Deciding on a search strategy and planning the research: target of the search, making a list of possible sources, finding and using the information, reformulation of the reprocessed information product.

2. Knowing the sources:

   (a) formal sources: various tools enabling sources to be identified at various search levels or for different types of document (books, periodicals, conference reports, theses, patents, standards ...);

   (b) informal sources: organizations that generate information, professional gatherings ... ;

   (c) various sources of information on products, companies, areas of economic activity, distribution, customers, prices, indexes and ratios, setting up of industries, machines and equipment, advertising, legal and social questions, international issues.

In each case, the sources are identified and the method of accessing them is given.

This guide, produced in 1990, is clear, concise and user friendly. It is a distinct improvement on the traditional guides on bibliographic resources.

(Sylvie MONY, Compiègne, France)

3.7 Manual on information retrieval in chemistry, produced by the Central Library of the University of Veszprèm, Hungary

In 1989, the Central Library at the University of Veszprèm produced an educational document for chemistry students to help them carry out manual and computerized information searching. It has some 30 pages and is divided into two sections.

The first section (20 pages) deals with traditional and manual methods of information retrieval concerning chemistry. It opens with an introduction to Chemical Abstracts (CA), indicating the weekly issues and volume indexes, and then gives information search methods for the CA. Next follows a description, with numerous examples, of retrieval strategies according to different criteria (generic terms, names of chemical substances, molecular formulae, authors' names, patent numbers ...).

The second section (about 10 pages) deals with on-line specialized literature searching at the Central Library. It then goes on to describe teleinformatics networks, such as the STN and its command language, various Chemical Abstracts data bases, and practical methods of linking up to and consulting these data bases.

This document, which is very instructive and detailed, is particularly suitable for students who have to learn how to carry out information searching in chemistry.

(Anna DÖMÖTÖR, Veszprèm, Hungary)

3.8 Guide to information resources at the central and department libraries at Imperial College of Science, Technology and Medicine, London (United Kingdom)

The central library (Lyon Playfair Library) and associated department libraries at the Imperial College of Science, Technology and Medicine (London) have drawn up and distributed various introductory guides to information resources. Both simple and practical, they cover the various specialized information sources for different fields of engineering and are intended for engineering students. Each one- to five-page volume contains useful information such as:

introductory remarks (e.g. 'This is only an introductory guide to access resources. For more information, please contact Mr X, information specialist in this field');

general classification codes in the field in question;

guidelines for finding documents;

a selection of basic works;

a list of specialized journals;

reference and abstracting journals;

relevant data bases;

the congresses and conferences concerned;

reports and theses available;

conditions of access to department libraries;

other London libraries;

the name and telephone number of the information specialist in the particular field.

Some 15 educational guides of this kind are available to students.

(Magda CZIGANY, London, United Kingdom)

4. SPECIFIC TRAINING MODULES

In a number of universities or engineering colleges, specific information management training modules for engineering students are generally set up by those in charge of the library or documentation centre, with the agreement of the university or college authorities. In most cases, these modules lead to evaluation of the student's work and the awarding of credits.

4.1 Introduction to scientific and technical information for students at the Ecole Nationale Supérieure des Mines (Paris)

Type of course

An introductory scientific and technical information module for first-year students, covering use of the library and information facilities, followed by an introduction to computerized documentation.

Description

Set up by the school's Directorate of Studies in co-operation with the library, this introductory course is intended for all first-year students (under the French system, the first year is the third study year after the end of secondary education) and consists of two stages.

(a) In November, there is an introductory session to the library and information retrieval facilities lasting an hour and a half for groups of 20 students (four groups in all). Practical exercises give students a chance to handle the principal tools (manual or computerized files, CD-ROM, statistical directories, company reports, encyclopaedias). The students then carry out literature searching on subjects such as the erg function, the definition of a pulsar, quarks, the world annual production of titanium, the development of natural gas production in Norway between 1975 and 1981, location of companies or foreign universities, etc.

(b) The following February, the students are introduced to the use of computerized documentation and data banks as part of guided work during the information technology course. Each session lasts two hours for each group of 20 students (four groups). The sessions are held in a lecture theatre and require the use of a microcomputer with a communication card and a liquid crystal display (for wide-screen projection). After a brief theoretical presentation of data bases used in France and elsewhere, students are given a demonstration of on-line information searching accompanied by comments on search strategies.

This introductory work is carried out jointly by a lecturer and a documentalist from the library.

(Jacqueline LEROY, Paris, France)

4.2 Communication and information retrieval module at Napier Polytechnic of Edinburgh and students' coursework

Type of course

This course is intended for first-year students in the civil engineering department and comprises lectures and individual work.

Description

(a) The communication and information retrieval course

The course is designed for first-year B Sc students in the civil engineering department (similar courses are offered in other departments). It takes the form of weekly sessions during the autumn term. The objective of the course is to show students how to conduct information retrieval and handle communication within the Polytechnic and in the world of industry. The topics dealt with (10 sessions) are, in order:

introduction to course, library and catalogues;

information flow and literature types;

reference material (secondary documentation);

British Standards;

journals;

indexing and abstracting journals and on-line retrieval;

citation and bibliography;

abstracting techniques;

written reports;

oral presentation of information.

(b) Individual coursework

Each student is required to write a technical report of 1,500 words on a topic assigned from a list. The word limit does not include all the prefatory material, bibliography (some 25 items) or appendices which may be needed. In addition, a separate set of citations is required to indicate the sources of information used in the report. All reports must be illustrated with appropriate cross-sections, flow diagrams, graphs, charts or tables, which must be linked to the text to show their relevance. Students have about a month to complete and hand in the coursework.

The 30 subjects suggested include drainage systems, tall building construction, railway tunnels and foundation design.

(David A. CUMMING, Edinburgh, Scotland)

4.3 Courses available at schools of engineering in Indonesia on the various aspects of specialized information and the use of documentation services

Context

Various schools of engineering in Indonesia.

The Indonesian Science Institute (LIPI), which represents engineers.

Type of course

Specific courses or seminars, of medium length, on all aspects of information for engineers.

Description

Since 1980 several short training courses (two weeks, 84 hours) have been given on the methodologies of technological search, the drafting of scientific and technical reports and the preparation of scientific publications.

These courses have been devised and supervised by the Chairman of the LIPI's Technology Committee. They are intended for students at engineering colleges, lecturers and assistants at these colleges and young engineers working in research institutes, or in the research divisions of national agencies or Indonesian companies.

The training consists of lectures and practical work concerning the use of libraries and information services, bibliographic and documentary retrieval, current awareness of technological developments and the drafting of summaries and abstracts.

Only one day of the two-week courses is devoted to a theoretical introduction to libraries and information services and two days to using the relevant tools. For the rest, which is the most essential part, students are required to carry out practical documentary retrieval procedures and summary writing, which is more stimulating for them than theoretical instruction about libraries.

(Sri WIDATOEN DARJOTO, Bandung, Indonesia)

4.4 Scientific and technical information and communication training module or credit at the Conservatoire National des Arts et Métiers (Paris)

Type of course

This training module, which leads to an engineering diploma course credit, focuses on the handling of the tools and resources of scientific and technical information and communication.

Description

The Conservatoire National des Arts et Métiers (CNAM) or College of higher technology for training in the application of science to industry, established in 1794 in Paris, has a long tradition and experience in training engineers through continuing or in-service training programmes. It provides courses for company technicians and senior personnel who want to become engineers in different branches of the profession.

Since 1976, the CNAM has offered an original scientific and technical information and communication training module designed to develop the awareness of the scientist or engineer in using and generating information.

This training - essentially methodological - seeks to facilitate access to relevant information, introduce students to procedures for remaining alert to technological information developments and foster rational working methods which will help to promote scientific activities. Obviously, most emphasis is placed on methods of obtaining information, using it scientifically and communicating it to others, and on the tools relating to patents and national and international regulations.

The programme, intended for company employees, consists of two-hour courses held twice a week, making a total of 100 hours for the 25-week course.

The programme is centred on the following six modules:

general concepts of information;

basic scientific theories of information and communication;

technical knowledge needed to use information effectively (categories of information, documents and dissemination channels);

information management methodologies (needs analysis, information retrieval, scientific use, generating and communicating information);

industrial information (patents, brands, designs, standards);

current awareness of technological developments.

(Danielle BRETELLE-DESMAZIERES, Paris, France)

4.5 Training seminar in information and documentation methodologies for students working for the postgraduate Diplôme d'Etudes Approfondies (DEA - Diploma of Further Studies) in science and technology (building construction)

Context

Ecole Nationale des Ponts et Chaussées (National School of Civil Engineering) (Paris, France)

Ecole Centrale des Arts et Manufactures (Central School of Applied Arts and Manufacturing) (Chatenay-Malabry)

Centre Scientifique et Technique du Bâtiment (Scientific and Technical Building Construction Centre) (Paris)

Type of course

Specific module (seminar) designed to train postgraduate students working for a DEA in building construction science and technology to use information and documentation methodologies, so as to help them to carry out their individual scientific research.

Description

(a) Objectives

Lecturers preparing students for the DEA in building construction science and technology, in co-operation with the heads of the libraries and documentation centres of two Paris-based schools of engineering and a national research organization covering a specific sector, the Scientific and Technical Building Construction Centre, have set themselves the following objectives:

to ensure, early on in the academic year, that student researchers in this particular field have full awareness and understanding of the information services and resources available to them when preparing their theses;

to accustom students to carrying out literature searching, using the principal sources available and modern methods of information access, and to familiarize them with the documentation centres of the schools of engineering and research organizations concerned;

to monitor the acquisition and assimilation of this knowledge.

(b) Organization of the training

The training takes the form of a three-day seminar for a group of 15 to 20 students. It forms part of their regular timetable and is usually held during the autumn term (about a month into the academic year). After the seminar, the students carry out personal information retrieval work, either alone or in small groups, on subjects relevant to their future DEA theses. Their work is evaluated, what they have learned is tested, and marks are given that count towards the Diploma.

(c) The functioning of the seminar

The seminar alternates theoretical instruction with visits to libraries and documentation centres and practical exercises (especially consultation of data bases). Since students are required to work at three sites that are some distance apart, the sessions are organized on a half-day basis, spread over one or two weeks.

The central themes of the seminar are usually:

the importance of specialized information for engineers and researchers: political, strategic and economic data;

specialized information systems: survey of all the various kinds of facilities available in France and elsewhere;

specific tools and resources for building construction science and technology (technical and research organizations, information and documentation centres, specialized journals, sector-based data bases and data banks, symposia, conferences);

research methodologies, especially those dealing with documentary retrieval, presented from the problem-solving standpoint;

the heuristic approach to information (e.g. how to carry out information searching in a multidisciplinary group without using traditional documentation methods).

Students are required to work in groups on subjects that concern them directly. They also have privileged access to the skills of information specialists at their place of study.

Evaluation of the course

The seminar has been in operation for several years and would now seem to be an essential part of the methodological instruction which should be given in all postgraduate training and even towards the end of the engineering students' diploma course, when they are engaged in individual or group projects.

A balanced partnership between teaching staff and information specialists (who should be paid on the same basis as lecturers for their teaching services) is a basic condition for the success of this training activity.

(Jean MICHEL, Paris, France)

5. TRAINING COURSES INCLUDED IN THE GENERAL CURRICULUM

A more original but less frequent practice is the inclusion of information management courses in the general curriculum of studies of the establishment concerned, whether these are studies in specific disciplines or training modules of a more methodological kind. These courses are devised and taught under the joint responsibility of information specialists and lecturers in the relevant field.

5.1 Information retrieval and oral presentations by students as part of the materials course at the Ecole Nationale des Ponts et Chaussées, Paris

Type of training

As part of the materials course in their first year at the school (the third year of complete engineering studies), students, working in pairs, carry out literature searching on a particular topic, analyse their findings and present them orally.

Description

(a) Objectives

Lecturers who give the materials course consider, together with the heads of the school's documentation centre, that instruction in information management should have the following objectives:

constitute the 'individual work component' that students are required to complete during their instruction;

enable the acquisition and assimilation of knowledge to be assessed;

get students accustomed to practising literature searching, using the principal sources available and the most up-to-date methods of access;

accustom students to make oral presentations, using the various aids available.

(b) Organization of the training

Some 20 subjects are proposed by lecturers responsible for the materials course (ranging from the ageing of polymers to the use of geomembranes, and including coal tars and oils and their uses in civil engineering, or, again, the corrosion of metals in soil).

Students are divided into pairs at the first session and they choose their subject. To make the start of the work easier, they are given one or two basic bibliographic references. Each team can ask for help from:

lecturers: a temporary assistant is assigned as a leader for each subject and can be contacted by telephone at his or her place of work during the training;

the school documentation centre: students can make one or two appointments with documentalists and engineers for advice.

Students can call upon all available sources of information concerning each subject, whether formal or informal, primary or secondary, manual or computerized. Consulting data bases is strongly recommended, but students are also encouraged to make a direct approach to specialized research organizations (learning in this way, how to penetrate these closed environments).

The students are given reference cards with the following details:

title of subject;

description of subject (five to ten lines) and scope (or limits) of the information search required;

knowledge to be explored in depth (referring back to school classes);

bibliographic pointers (one to three references);

organizations to consult (one or two research centres);

leader (name and phone number).

(c) What students are required to do

Each team of students is required to:

make a written report setting out all their search procedures (the data base listings must be attached);

make an oral report (ten to fifteen minutes) presenting no more than a part of the work (all teachers and students take part in these presentations).

The teams are assessed and marked according to the quality of their information search, the relevance of the links established between the course and the information obtained during bibliographic searching, and the quality of the written report and the oral presentation.

Evaluation

The work provides strong motivation for students to discover for themselves the scientific and technical subjects in the syllabus; what is more important, they acquire first-hand knowledge of information retrieval methods. No prior instruction is given concerning documentation tools and resources (finding out about these forms part of the training objectives).

The excellent co-operation and perfect synergy between lecturers and information specialists are key factors in the success of this type of training.

(Irène ITARD, Paris, France)

5.2 Training students at the Ecole Nationale Supérieure des Mines, Paris, in information retrieval methodologies, as part of biotechnology instruction

Type of training

Individual information retrieval practice carried out by second-year students taking the biotechnology option.

Description

This methodological training involves second-year students (fourth year after the end of secondary education in the French system) taking the biotechnology option. It consists of the following stages:

(a) In January, students familiarize themselves with the general and specialized works and periodicals available at the library, as well as the various data bases. At this stage they are assisted by library information specialists.

(b) Subsequently each student prepares a scientific (or less frequently, technical or economic) bibliographic subject, which enables him or her to learn information search techniques. The student then makes a critical analysis of the chosen scientific articles and gives an oral presentation summarizing the conclusions at the end of the academic year. A written bibliographic report is also submitted to the lecturers in biotechnology.

This training is carried out by biotechnology lecturers in association with library staff.

(Brigitte ROCHE, Paris, France)

5.3 'Integrated exercises' and projects by new students at the Université Catholique, Louvain-la-Neuve, Belgium

Type of training

Individual work by students starting their engineering studies, using information search procedures.

Description

The aim of the course is to combat the excessive emphasis placed on students' capacity for analysis, having regard to the fact that an engineer's work is essentially rooted in creativity, synthesis and design. The training also seeks to combat the compartmentalization of the various subjects taught in the course.

The University's Faculty of Applied Sciences has, over the past ten years, introduced projects for first- and second-year students which it terms 'integrated exercises'. These projects, dealing with actual problems such as designing a lifting electromagnet, calculating and simulating the trajectory of table tennis balls, designing new kinds of chairs, or building a high-speed rail link for Belgium, take up 135 hours of the students' timetable during the first year and 90 hours during the second. About 50 out of some 250 students choose these exercises, which are carried out in small groups.

The students are expected to obtain information and consult specialists from the faculty departments or outside experts. Reports are prepared and presented in public. In some instances, the students' work can lead to the publication of monographs.

The projects, which are greatly appreciated by students, enable them to learn a good deal and to acquire a better grasp of the theories taught to them. The methods used in implementing the project and in seeking information help to develop creativity in the students and encourge a drive for consolidation in their work.

The exercises require a great deal of supervision and regular renewal of the subjects covered.

(Auguste LALOUX, Louvain-la-Neuve, Belgium)

5.4 Mini-projects in mineral and organic chemistry, using bibliographic data, at the Ecole Nationale Supérieure de Chimie, Lille, France

Type of training

Groups of students are asked to carry out mini-projects on the basis of bibliographic searching and to use their findings to prepare consolidated reports.

Description

(a) Objectives

The aims of the school authorities and lecturers are:

to motivate engineering students to carry out specialized information retrieval;

to make documentation intelligible to students;

to teach them to select relevant documents, organize the data and reformulate the information according to their needs (bibliographic reporting), and to form their own opinions about often contradictory ideas.

(b) The mini-projects

The idea is that students in their second year at the school (fourth year of their full engineering course) should carry out a 'mini-project' using bibliographic data, instead of being given predetermined laboratory work as in the past.

The work is organized as follows:

selection by groups of between four and eight students of a mineral or organic chemistry subject;

introduction to manual and computerized bibliographic search procedures;

practical bibliographic searching;

preparation of a consolidated bibliographic report;

carrying out of the practical part of the project (laboratory work) using the bibliographic data;

preparation of a practical report.

(c) Theoretical lectures (12 hours)

The theoretical part of the introduction to information retrieval and the use of documentary tools covers the following topics:

description and use of the university library and the main documentation centres;

description and use of chemistry literature: primary, secondary and tertiary documents;

layout and use of Chemical Abstracts, essential for any chemistry research;

operation, structure and use of the various computerized information systems;

description of chemistry data bases and data banks;

drawing up of a search strategy for a specific subject: identification of principal ideas and key words, transition from natural language to machine language;

method of reformulating the information in the form of a bibliographic report.

These topics are summarized in a photocopied document.

(d) Bibliographic reporting (50 hours)

Equipped with this knowledge, students start by finding out about the information tools and resources available. Then, with the help of the lecturer, bibliographic searching is organized (manual search, definition of concepts, key words and data base inquiry strategy, computer terminal work).

Students then have to sort the data collected and make their selection in order to prepare a complete bibliographic report on each of the subjects chosen.

(e) Practical work on mini-projects (80 hours)

The experimental mini-projects are carried out in the laboratory over a two-week period, using data from the bibliographic reports. All results, observations and comments are then recorded in a practical report.

Evaluation

The objectives of the training have been very largely attained due to the fact that the incorporation of scientific and technical information searching into an individually devised project encourages the engineering students to apply and further develop the theoretical principles they have learned in class, to find and select the relevant documents and to reformulate this information in the form of reports.

(Gérard HUYGE-TIPREZ, Villeneuve d'Ascq, France)

5.5 Training module in management, the starting-up of a business and information retrieval at the Université de Technologie, Compiègne, France

Type of training

An introduction to information retrieval methods is incorporated into a management training module dealing with the starting-up of a business enterprise.

Description

(a) Context and objectives

The Compiègne University of Technology offers five-year courses in biological, chemical, information technology and mechanical engineering. During their studies, students work for credits in scientific and technical subjects linked to their specialization as well as credits in general education offered by the Human Sciences and Technology Department.

'Engineers as potential creators of business enterprises' is the slogan adopted by the lecturer from this department who devised the credit course in 'Management basics' after observing that students usually have little interest in management techniques because they do not realize the importance of what is involved. The course seeks to motivate students by proposing that they take part in a plan to start up a business.

In this context, the students come to understand the need to have the best possible information available. Library staff help them to learn about information retrieval methods.

(b) Organization of the training

Side by side with their normal lectures, 20 to 30 groups of three or four students are required each semester to carry out a guided group work project which calls upon them to design a new product, assess its market potential, define production methods and the resources required to manufacture and market it, work out a business strategy and put forward plans for its financing. Finally, each group submits a new business enterprise file to a jury made up of lecturers, bankers and industrialists who decide whether the project is feasible.

When required to see themselves as entrepreneurs, students are obliged to seek out the relevant information and data on the potential market for the product, the labour market, raw materials and equipment, the business property market and the tax situation. This gives them an opportunity to learn about the compilation, analysis and reformulation of data, all of which is carried out in close co-operation with the lecturers supervising the guided group work and library staff.

(c) Active learning in information retrieval

At an initial session, a rapid survey of the various information sources is given: directories, guides, specialized journals, statistical documents (such as those available from the French national statistics office, INSEE) and videotex (Minitel in France) services. A three-page guide is given to students to help them with their first steps in research.

After some individual work, the students meet library documentalists in order to obtain their help in tracking down and using specific sources. Methodological work is introduced at

this point to help students define their needs, cross-check the information (use of different terminology or consultation of different statistical sources), cope with time-limits and budget restrictions, and, finally, fill in by themselves the information that they cannot obtain.

Assessment of the students' work takes full account of the information retrieval aspect. Throughout the project they are required to note the references of the sources used; they also have to give the broad lines of their approach.

Evaluation

As this is a practical course centred on information retrieval (rather than specific training in bibliography), the aim is to give the students an 'information reflex' that will serve them throughout their careers. In order to achieve this, it is vital that the students should be motivated by their personal project.

This aspect is reinforced by the individual attention given to students, who seek advice on other credit courses or personal work.

The fruitful partnership between lecturers and information specialists has also led to joint participation in a research team studying technology transfer.

(Sylvie MONY, François ROMON, Compiègne, France)

5.6 Training in information retrieval methodologies as part of the 'new projects and products' option at the Ecole Nationale Supérieure des Mines, Paris

Type of training

Individual work in information retrieval and synthesis, to back up the methodological training of students taking the 'new projects and products' optional course at the National School of Mining Engineering.

Description

The 'new projects and products' course offers students methodological training which cuts across the lines of the traditional disciplinary approach. Its emphasis is on management of innovation at the interface between product design, project management, organizational analysis and business enterprise strategy. The lecturers see the intensive use of scientific, technical and economic information as a desirable and, indeed, necessary element in this strategy.

After an introduction to library facilities and resources, students taking the 'new projects and products' course are given instruction in industrial and intellectual property (how to read a patent, how to use patents in effective technological development monitoring procedures), and in marketing and market research.

This knowledge is then tested by means of two personal projects.

The first is a sector-based study linked to the branch of technology chosen by the student. In a written report, the student is required to assemble economic data concerning the sector, explain how it is organized (degree of concentration, number and size of companies,

trade unions and associations), and locate sources of information (journals, laboratories, data bases, trade exhibitions). Studies have been carried out in this way on the toy manufacturing industry, tap fitting manufacture, the marble industry and the construction of PVC 'woodwork'.

The second project is a study of patents. The student is required to comprehend the technological strategy of a company by analysing the patents which it holds in comparison with those of its competitors or to review technological research on a given product, by examining the registration of patents.

Students gain access to information by using the school's documentary resources and by consulting data bases with the assistance of its information specialists.

Training is increasingly concerned with methodologies and can no longer be given in the traditional manner. The approach adopted by the National School of Mining Engineering is to teach students how to find the information they need by using all the available information resources, and especially computerized resources.

(Patrick GARNIER, Paris, France)

6. INNOVATIONS IN TEACHING METHODS

In some cases, the information management learning process can become a real source of innovation and experiment in new teaching methods. Here is a further way in which an engineering school has approached the question.

6.1 Pre-entry methodology seminar at the Ecole Supérieure d'Informatique-Electronique-Automatique, Paris

Type of training

This pre-entry methodology seminar is intended for first-year students and seeks to familiarize them with methodological tools and show them what data are available on the methods involved in the learning process, the processing of information and personal development.

Description

(a) Objectives

In order to respond to the students' self-proclaimed need to tackle their higher education studies with a greater degree of adaptability and efficiency, the school has set two objectives:

to teach students elements of methodology for organizing and managing their study time and scheduled programme at a very early stage;

to make them aware of the importance of thorough mastery of the cognitive learning process and of personal development.

(b) Organization of the training

All first-year students attend a two-day seminar before the start of the academic year (in fact two such seminars are held for groups of 160 students). Each group is split into two so that theoretical instruction can be alternated with practical work on planning and organization. Teams of eight to ten students are then set up, each working under the supervision of two second-year students (leaders of the school's quality circles) and overseen by a third-year student.

(c) The functioning of the seminar

Students in the subgroup concerned with planning and organization are given a set of printed reference cards devised by the school, a valuable instructional aid for the group leaders, setting out rules connected with the image and running of the school and, in particular, with methods of intellectual work. One side of the card sets out brief outlines of problems of a methodological kind ('the lecture and its basis for your work', 'working to a deadline', 'drawing up your timetable', etc.). The other side shows the school logo. Under the enthusiastic guidance of the student group-leaders, a question-and-answer game is started using the subjects on the cards. Gradually drawn into the situation, the new students work out an imaginary but individual timetable and learn to ask each other questions about key themes in the coursework and to make a weekly individual or group assessment.

In the other subgroup, the students are given theoretical instruction about learning methods and how the brain works. They learn the importance of information and find out about the mechanisms of absorbing and recalling facts. The lecturers show them, in a practical way, the links between information and educational applications with the aim of helping them make the most of their instruction. They also learn to 'decode' the cognitive learning process, using the explanation given on one of the cards called 'Studying a science or a chapter requires ...' .

The seminar ends with a wide variety of somewhat complex information that encourages students to evaluate and select the facts that will make it easier for them to equip themselves for their studies.

The school has also set up quality circles made up of students; these meet every two weeks and concentrate on solving problems concerning information, methodology and the learning process. The principal aim is to encourage students to handle and exploit information more effectively and to give them the skills that will enable them to do this throughout their careers.

This is a highly innovative and up-to-date approach, another way of looking at the question of information education in engineering colleges.

(Arlette LOFFICIER, Paris, France)

6.2 Information retrieval training on 'controversial' topics at the Ecole Nationale Supérieure des Mines, Paris, as part of the optional course on the socio-economics of innovation

Type of training

Students taking the optional course on the socio-economics of innovation compile individual files on 'controversial' technical, economic and industrial subjects.

Description

The lecturers ask students to compile individual files on highly controversial subjects such as the abortion pill, memory as a property of water, whether Airbus A320 should have two or three pilots, television audience measurement, the patenting of living matter, systematic screening for AIDs or building underground motorways through Paris.

The subject of study should be one that will give rise to heated debate and have scientific, technical, economic, political, ethical or cultural implications. In this way, students come to see the difficulty of separating the technical aspects of new developments from their social dimension, and realize that many opposing and incompatible viewpoints exist.

The work involves information retrieval by data base interrogation and interviews with those involved in the debate. The students then have to draw up a consolidated report in three parts:

description of the main people involved and their technical, ethical or economic arguments;

statement of the critical issues on which the debate is centred (describing any power relationship or influence between the parties);

writing scenarios describing how the controversy might develop.

The students are asked to add an appendix setting out all the information they have collected and used. Information retrieval is carried out through data bases (press, scientific literature, patents) with the help of library documentalists.

But the most original aspect of the project is the organization of interviews with eminent persons identified by means of the data bases. This helps to highlight the complementarity of written and oral sources.

The best files submitted are published in journals.

(Michel CALLON, Paris, France)

6.3 Innovations in teaching methods that see the information process as a form of training in itself: experiments carried out within the framework of the French 'Médiances' association

Context

Various university institutes of technology and engineering colleges in France, in conjunction with the Médiances association.

Description

The Médiances association brings together lecturers from university institutes of technology and engineering colleges as well as company directors interested in information training and scientific and technical communication.

For Médiances, the information process is a form of training in itself and implies a teaching approach based on autonomy and interdisciplinarity.

The work done by members of Médiances in their own establishments ties up with actual objectives rooted in the specific circumstances of industry.

Projects carried out in recent years include:

training in scientific and technical information and communication, in foreign languages, for engineers and technicians working for companies in the electricity and electronics sector;

the design and use by engineering students of simulation software for managing energy in industrial processes, regarded as a tool for gathering data and as a means of scientific and technical information management training;

design and operation by students at the higher technical level of a domestic automation system prototype, a process that helped them to grasp the dynamics of scientific and technical information;

development of students' awareness in regard to methods of acquiring specialized information by requiring them to carry out a survey in a service company (management of technical equipment for buildings).

These various activities were based on an original teaching approach which sought to encourage students to learn through projects while stressing the importance of thorough mastery of information facilities and resources.

(Médiances, Evelyne BROUZENG, Gérard MATRICALI, France)

6.4 An experiment in parallel, transdisciplinary training for students in electronics and those studying documentation at two university institutes of technology in Bordeaux, France

Type of training

A practical experiment in learning to work together for two groups of students - future electronics engineers and documentalists - centred on training in information retrieval and consultation of data bases.

Description

Two university institutes of technology in Bordeaux, one training high-level technicians and the other documentalists, devised a novel joint training programme in information management.

(a) The objective

To train students following different courses of study in information retrieval and data base searching, by means of a parallel, partnership-based approach.

(b) The two groups involved

Students in electronics were asked by their lecturers to carry out a study of an electronic mechanism or system, the aim being to make them aware of the importance of documentary and bibliographic searching.

Students following documentalist studies, whose educational background is often of a literary kind, were called upon to carry out scientific and technical data base searching.

Both groups of students were in their second year at university (second year following the *baccalauréat*).

(c) The experiment

Under the guidance of their lecturer and working in small teams, the electronics students informed the documentation students of their information requirements in order to solve the problems involved: what they planned to do, the context of their project, why the information was required, etc. A discussion ensued with the aim of pinpointing the area of research and the particular fields of study and establishing the research equation. The documentation students then proceeded with their information retrieval work.

The next meeting was devoted to establishing the final version of the research equation and consulting data bases, an operation carried out on a computer terminal by mixed teams of electronics and documentation students.

Evaluation

This original project, part of a new approach to information training, highlights the need for information specialists and experts in technical fields requiring information to work together. The idea of joint work by two groups of students destined for different professions is an excellent example that deserves to be widely followed.

As far as the strictly training angle is concerned, it should be pointed out that the electronics students became aware of the need to formulate their questions more accurately and to define the problems related to their search for information. Knowledge of search languages (synonyms, hierarchy of terms, semantic references) was acknowledged to be essential by the students, just as they realized the importance of being able to describe scientific and technical objects in simple language (explaining to the documentation students the workings of a convector or a telephone exchange in easily understood terms). Another advantage of the experiment was that they discovered the importance of the information industry.

The project forms part of a new attitude to occupational training which, instead of emphasizing the traditional, positivist acquisition of knowledge in a given scientific or technical field, stresses the need to train mixed, interdisciplinary or transdisciplinary teams where the potential of different professions can be combined.

(Marie-France BLANQUET, Bordeaux, France)

7. CONTINUING TRAINING AND SKILLS OF TWO KINDS

Following their qualification, engineers can continue to study information management. Through various postgraduate courses or continuing training, young engineers can improve their knowledge of scientific and technical information management or even specialize in the subject, thus acquiring dual proficiency.

7.1 Postgraduate training programme for specialists in scientific and technical information at the Institut National Polytechnique de Lorraine, France

Type of training

Postgraduate (long) course for dual proficiency as engineer and scientific and technical information specialist.

Description

The Department for the further training of engineers and senior personnel at the National Polytechnic Institute of Lorraine (which incorporates several engineering colleges in Nancy) organizes a nine-month training course for graduates, mostly young engineers or scientists. The aim is to equip them for the management of scientific and technical information and, more especially, for the handling of the new technologies for the processing of information.

The training is split into 15 specific modules, totalling some 685 hours of instruction, guided practical work, lectures and seminars. A project is carried out towards the end of the training.

The subjects dealt with include linguistics and machine language, multilingualism, information sources, information processing, computer-based information, artificial intelligence, new technologies, legal aspects of information, the economics of information services, communication, dissemination of information, management of industrial knowledge transfers and alertness in respect of technological developments.

(Daniel MOREL, Nancy, France)

7.2 Continuing training programme in information services and resources management (IRM programme) at the University of Technology, Helsinki, Finland

Type of training

A continuing training programme in dual proficiency designed to give engineers the ability to develop and manage information resources in their own professional environment.

Description

The Centre for Continuing Education at Helsinki University of Technology runs a nine-month course for university graduates, most of them engineers or scientists, working in companies or government administrations. The aim is to enable these young engineers to

develop and manage information resources systems, especially in the organization that employs them.

The training is divided into ten separate modules of lectures and seminars. Exercises are prepared by participants who concentrate on projects concerning their own organizations.

The subjects covered include managing information flows, project management, knowledge management, information technology, information audit, national and international information policy, information service strategy, and the value and price of information.

(Merja KARIVALO, Helsinki, Finland)

7.3 Continuing training module on 'scientific and technical information and communication' at the Conservatoire National des Arts et Métiers, Paris

Type of training

Continuing training courses for company engineers on managing the tools and resources of scientific and technical information and communication.

Description

The Conservatoire National des Arts et Métiers (CNAM), (College of higher technology for training in the application of science to industry), established in Paris in 1794, has a long tradition and experience in training engineers through continuing or in-service training programmes. It provides courses in various engineering disciplines, and students include company technicians and senior personnel who wish to train as engineers, as well as engineers and scientists seeking to further their knowledge in different subjects.

A programme of continuing training courses is accordingly offered. The first course is split into two three-day blocks (42 hours in all) and covers the acquisition, management, use and communication of information. The other, lasting three days (21 hours), covers strategic information, patents and standards, viewed as tools for industrial development. Both courses are intended for engineers, technicians and scientists.

(Danielle BRETELLE-DESMAZIERES, Paris, France)

8. PERSONAL ACCOUNTS AND SUGGESTIONS

Several lecturers and heads of documentation units at engineering colleges in a number of countries have given their views on the question of information management training. The following accounts reflect new ways of developing engineering training that will enhance the information dimension of the students' future careers.

8.1 Training young engineers or engineering students in specialized information management in the countries of the South

by Laurent GOMIS
(ENSUT, Dakar, Senegal)

(a) General remarks

For several years now, UNESCO has been extolling the right to information but the problem in the countries of the south is still access to that information, despite the efforts made by States as part of their various scientific and technical information services.

A threefold effort should be made in engineering colleges:

to gear information (which may be economic or legal as well as scientific and technical) to existing and potential needs;

to have a sufficient number of well-trained scientific and technical staff available;

to teach future engineers to use information.

Information must form an integral part of working methods, which means that the methods of using it must be taught to students. Acquiring information involves a learning process.

In Africa, documentation activities have only marginal status. There are few or hardly any children's libraries. School libraries are practically non-existent. Pupils only come across documentation at a late stage in their education, and often they reach university without seeing or using files. They are incapable of carrying out the slightest documentary search activity. University libraries are still the poor relations of the university system. Once settled in their careers, our senior staff cannot discard the poor information habits they acquired at an early age and which were reinforced throughout their education.

This raises the problem of renewing knowledge at their level. There is universal agreement nowadays that the acquisition of knowledge should go beyond the formal education system.

Information has become the most important raw material, a source of wealth conveyed all over the world, a vital resource and hence, a vital issue for the developing countries.

Our attitude to this overabundance, our opportunities for gaining access to these massive sources force us to call upon information techniques. Training is vital. Methods of information retrieval have to be learned and understood before a new attitude can emerge.

These methods must help researchers, teachers and students to find information that answers their needs and, what is more important, direct them towards the sources of this information.

Engineering colleges now have to train a new breed of engineers, capable of completing their own education through their legitimate desire for research and creativity.

This new attitude to information must be extended beyond the university to enable engineers, technicians, researchers and indeed any interested individual to muster the necessary tools to tackle the challenges facing us all: competitiveness for our goods and industries, revitalization of agriculture, the battle against desertification, giving credibility to education, economic growth and so on.

Modern Africans, quite apart from university students, must know how to acquire information. Today's world is already a world in which information holds sway; in tomorrow's world it will be even more vital, with priority going to knowledge acquired through know-how and knowing how to get things done.

(b) The need for training

Failure to recognize the advantages information brings, the fact that needs are not clearly defined and ignorance about information sources are all factors that should convince information services and engineering colleges that they must undertake user education. In its preface, the UNISIST guide to the 'Education and training of users of scientific and technical information' states that 'the final goal of every single library, documentation centre, information service, national information system or regional network is to serve the users of information. Users of information are an integral part of and the final link in the information transfer chain ...' .

The whole process misses its main purpose if users do not know how to find the information they need even though it is available. Users should, then, be trained in the techniques that will help them track down the information they require.

The first step is to make users and decision-makers aware of this need and to give information specialists the necessary training.

(c) Status of training

Anne-Marie Adrianasolo believes that 'in a university environment, the content of the training programme must have a direct relationship with the users' course of study. This relationship is the chief motivating factor for students, who unfortunately tend to think only in the short term (what marks they will obtain in their final exams). The biggest motivation factor therefore comes from incorporating the training in the diploma course. The students have to recognize the intellectual usefulness of information training and/or appreciate that it is worth while for the successful completion of their studies'.

Several options could be proposed in the light of the specific characteristics of each country and each engineering college.

8.2 The role of university libraries in training engineering students to use information

by Vladimir T. BOROVANSKY
(Arizona State University, Tempe, Arizona)

The last ten years have been characterized by an increased effort to teach engineering students to utilize information resources. New courses in 'engineering information' began to appear in university programmes, and an increased effort on the part of engineering reference librarians/subject specialists to make class presentations, specialized seminars and 'open houses' contributed to this worthwhile activity.

At the same time, science and engineering libraries have been undergoing rapid changes. In most institutions the traditional card catalogues no longer exist, being supplanted by the on-line public access catalogues (OPAC). Data base searching is shifting more towards the end-user system with the proliferation of CD-ROMs and data bases loaded on the main university library catalogue.

For example, at Arizona State University several Wilson Indexes, including the Applied Science and Technology Index, are on the CARL OPAC and available for free unlimited searching. They can be searched not only on the library terminals, but also from the offices of academic staff or home PCs. Compendex (Engineering Index) is available in a CD-ROM form, also for free-of-charge searching. Patents, another important source of primary information, can be searched free on CASSIS CD-ROM supplied by the US Patent and Trademark Office (USPTO). The ASU Noble Science and Engineering Library has been selected as one of the 14 libraries nationwide to be the test site for the new Automated Patent System developed by the USPTO. This will enable the user to search the full text of patents dating back to 1790.

Additionally, the emergence of advanced communication networks like INTERNET enables both the information specialists and users to access other libraries' catalogues and selected files. This will greatly enhance their capabilities to search and find additional resources.

The increased international competition for new markets puts pressure on engineers to design better products and develop better materials. This leads to the 'internationalization' of information as we can see in the 1987 US National Academy of Engineering report. The key item considered by the report was 'gathering, disseminating and assimilating information from abroad'.

Although this addresses activities related to engineers who have already left the school, it is obvious that it is not simply lecturers in engineering or engineers working in research and development who should pay heed to this call. We must start preparing the future engineers for these skills. The information-gathering skills of the majority of engineers still need improvement.

All types of instruction activities aimed at improvement of 'library information literacy' of engineers and engineering students will eventually lead to a better knowledge utilization. Neglected utilization of engineering data leads to failures of equipment, economic losses and sometimes to disasters.

It is unfortunate that in some of our engineering schools there is still insufficient pressure on students to become more 'information literate'. Some of it can be traced to teachers who themselves were not aware as students of all the information tools the engineering library offered, and today as staff they are still not totally aware of all the possibilities their libraries offer. It seems as if interest has waned during the last couple of years at Arizona State University in the semester-long course on information resources in engineering. Part of the problem might be, of course, the additional cost and/or insufficient marketing on the part of the library.

At the same time, the number of students reached via class presentations and special seminars seems to be increasing. This would confirm the fact that more professors are becoming aware of the importance of training students in library skills.

In order further to improve this situation, we must, as information specialists, do a better job in advertising these courses to students and in educating faculty staff in regard to the importance of teaching future engineers to utilize to the full the resources available to them in the library. And most of all, we must convince the engineers that in order to close the knowledge gap, we need to make a gestalt switch from object-content thinking to dynamic knowledge-based thinking.

8.3 Practical suggestions for introducing specialized information courses at an engineering school

by Patrick GARNIER
(Ecole Nationale Supérieure des Mines, Paris)

The following recommendations are drawn from a scientific and technical information experiment carried out at the Paris National School of Mining Engineering by the team teaching the 'new projects and products' course with the support of the Scientific College for Product Design, Study and Research (CONFERE).

The use of scientific and technical information is centred on students' ability to:

sum up a scientific or technical question;

find possible outlets and applications for a given product;

explain how a given business sector is organized;

review the technological strategies of a given company;

review the various technological avenues explored by rival companies in regard to a particular product.

If students are to be motivated, these problems and circumstances must be drawn from real life. The National School of Mining Engineering does this by working with partners in industry and with a publisher of a professional newsletter or trade journal anxious to fill his files, and, when required, to deal with the questions arising from 'junior company' project. What matters is that there is a real customer waiting for a reply to the question.

The study must combine various methods of investigation and enable students to explore all the information techniques available: doing the spadework on basic documents, searching files, retrieving data from various computerized data bases, interviews, visits to documentation centres, meetings with experts and so on.

What is important is not the technique of consulting data bases (it is more cost-effective to entrust this to an experienced specialist), but the retrieval strategy, which requires proper preparation. Before going on to more sophisticated resources such as data bases and data banks, the student must have thoroughly searched the documentary sources on hand. The study must also include consultation of documents that have been identified as interesting, and this requires a certain amount of time. This search should, therefore, be spread over a period of time.

For the students to be motivated, the problem to be solved must be a real problem; this means that the lecturers should accept that they will not have prior knowledge of it and will discover it because of, and at the same time as the students. Staff must, however, be sufficiently knowledgeable in the field to guide students' research and confirm the findings.

In order to encourage their motivation, the study should expect students to:

make an oral presentation of their findings (one hour, including the presentation and subsequent discussion in front of their fellow students and guests who are experts in the field - and who would be 'customers' for their work);

submit a written consolidated report which is afterwards kept by the library. This gives the students a certain reputation, but demands work of high quality;

present a report intended for the trade press (for the School of Mining Engineering, des Editions A JOUR).

A good working relationship between lecturers and the documentation centre is required, and what is most important, a minimum budget for data base searches must be planned.

Examples of simple exercises for engineering colleges

(a) For a given product, ascertain the technological progress made by rival companies by examining the relevant patents registered over the past few years. Examples: taps and fittings, hi-fi speakers, metal purifying processes.

(b) Determine a company's technological strategy by following its patent registering policy. Example: Michelin's research and development strategy in France.

(c) Determine the current uses and outlets for a given product and quantify them. Examples: outlets for starch or tobacco, etc., in bio-industry.

(d) For a given industrial sector, describe its operations, trade balance, production structure, marketing strategy, etc. Example: describe the set-up of the toy manufacturing industry in France in 1990.

8.4 The teaching of specialized information courses at the Institut National Agronomique, Paris-Grignon

by Jean LOSSOUARN
(INA - PG, Paris)

This is not the place to make an exhaustive examination of the teaching of specialized information management to students at the National Institute of Agronomics. We shall simply give a few examples, chosen for preference from the 'technical' disciplines, and show how they fit into the overall problem area. This involves four complementary requirements:

motivating students to seek information;

teaching them basic documentary retrieval techniques;

training them to assess and select documents and information;

showing them how to optimize, present and communicate their findings.

(a) Motivating students to seek information

The aim is to develop the student's 'reflex' in regard to the seeking of relevant information, a major objective in engineering training nowadays.

In line with the particular teaching methods used at the Institute, a wide range of different activities help engineering students to acquire this reflex.

Because of the deliberate use of inductive methods alongside deductive reasoning and the organized way in which practical training is dovetailed into other activities, students are rapidly confronted with the need to find the information that is indispensable to them in establishing a set of references which will enable them to analyse, on a comparative basis, the characteristics of the agricultural enterprise where their practical training was carried out. As a second stage in the process, the students comment on these characteristics and, where necessary, suggest ways of improving them. The theoretical knowledge acquired in class certainly provides a frame of reference for this, but in itself it is necessarily inadequate, both because the practical course takes place very early in the programme and because the wide range of real-life circumstances and production systems encountered in the practical training cannot all be reflected in the classroom.

This type of situation will in fact reoccur at various stages during the training programme - and this is quite deliberate. The importance placed on optional subjects often makes it possible to work with small groups of about 20 students and this makes it easier to use active learning methods; students accordingly have a great deal of scope in planning their own timetables and adjusting their methods in response to the problems raised.

Furthermore, as in most similar establishments, the students carry out studies and surveys on their own initiative, under the contracts obtained by their 'junior enterprise', which is very active in the Institute. Here too, they find themselves obliged to obtain information and assemble a minimum number of documents in order to handle the problem raised correctly.

In all types of work that oblige students to look for documents on their own and therefore deal with information professionals and specialists, there is an element that is particularly important in view of the way our students act and react. In the past, they have been used to solving problems that have been clearly formulated using preselected information: this forms part of the competitive examination they have to pass in the selection process for French schools of engineering. Our task, then, is to put them in real-life situations, where we know only too well that questions will not always be clearly formulated and the data required to answer them will not be sorted in advance.

This first requirement of our training makes an active contribution to the acquisition of knowledge, in the same way as formal lectures do. But at the same time it gradually gives students a living skill by teaching them to react and decide on what course of action to take when confronted by a problem which may or may not be clearly expressed, and by leading them to make contacts and to exchange ideas with a wide variety of people - in short, to acquire a certain pattern of behaviour.

(b) Teaching students information retrieval techniques

Once the reflex of looking for documents and using information has been acquired, students must be given the methodological training necessary to rationalize the whole procedure.

In our case, having regard to the way courses and the overall teaching system are currently organized, this is a relatively gradual process. In fact, during the second phase of higher education (that is during their first two years at the Institute which are their third and fourth years of higher education), the students gradually identify and familiarize themselves with the main type of journals to which they have access, and with the resources of the campus libraries. They also discover the different categories of people they may need to consult, such as teachers, researchers, engineers and experts in professional organizations and technical institutions, senior personnel in the profession, and government and ministry officials. All these categories are well represented and relatively easy to contact in the Paris area. At the same time, the individual or group work done by students as part of guided activities is usually based on documents preselected by the lecturer(s).

After this stage, students are perfectly capable of drawing full advantage from methodological instruction on information retrieval as part of their final year of studies (the fifth year of higher education). This instruction seeks to give students a coherent overview of the principal information media in their field of training and specialization: different types of journal (scientific, technical and economic ... with or without reading committees), primary and secondary documents (analytical reports or abstracts, abstract bulletins, collections of journal summaries), data bases and data banks, identification of their producers and servers, etc. An individual bibliographic report, representing between 60 and 100 hours of work, gives students the chance to make practical use of all these tools. They are able to consult data bases and data banks in drawing up their reports, on condition that they prepare their inquiry strategy thoroughly in advance. After using the information resulting from the consultation, the students make a critical evaluation of these strategies.

(c) Training students to assess and select documents and information

In the face of the exponential growth of information production, it is more vital than ever to teach students to make critical assessments of sources and documents and this must be a constant underlying concern of the training programme.

As part of the instructional approach of which we briefly mentioned some aspects earlier, we try to create conditions that will oblige the students to maintain this attitude of mind permanently. This is what they are led to do from the start of their studies at the Institute, during the two 'pre-training' weeks that prepare them for their practical courses on farms. A major part of the work done during this period - about half the time in fact - consists of the utilization by students, working in pairs, of documents or recordings concerning the Institute farm, such as crop distribution and rotation, climatic data, demographic data about the various animal production units, and grazing calendars. The idea here is to get students to use raw documentary sources at a stage when their theoretical knowledge on the subject is extremely limited, so that they may identify material that can be used to determine how an aspect or component of the farm is run. Put together, these isolated steps provide the students with an initial reference framework which they can use to dissect and begin to understand the running of the farm from their first stay there.

The report written by each student after two practical training periods on the farm, which carries considerable weight in the course assessment, entails the constant practice of searching, evaluating and selecting information sources in order to construct the essential frame of reference for making a critical appraisal of the operation of the unit being studied.

More generally, almost all the individual or group work done during these optional studies, combined with the projects devised and implemented by students and their bibliographic search reports, help them to acquire this habit.

It is also through work of this kind that students become familiar with the specific characteristics of economic information, as opposed to scientific information: the importance of the overall economic situation and the fact that certain data may be outdated, the 'bluff' factor, the influence of advertising or, conversely, the fact that information may be withheld. The students will also find out that the various types of information have different 'rhythms', because, for example, they are linked to biological cycles of greatly varying length. Whereas statistics concerning the structure of a herd of breeding cows may be very useful in forecasting levels of milk or meat production, knowing the number of day-old chicks at a poultry farm does not have the same usefulness in forecasting poultry production, because by the time these figures have been made available the hens have already been killed.

In short, it can be said that both searching for and using documentation with a particular objective in mind demands a special skill that all engineers nowadays need to master.

(d) Showing students how to optimize, present and communicate their findings

Students must become accustomed to targeting their information work. They should be urged to become increasingly strict with themselves about this because there are so many kinds of communication competing for our attention nowadays.

The students must be trained to produce concise, well-written documents conforming to accepted rules on presentation and setting out sources systematically. The spread of word processing software has enabled great progress to be made in this respect. As the target groups in professional life today have less and less time to read, over-long reports should be strongly resisted, and the preparation of summaries and their translation into one or two foreign languages should be made compulsory.

Students should also be taught to create and use other communication media: producing posters, for instance, proves to be a hard school in keeping to the essentials. The advantages of audio and video cassettes are obvious, but it should be pointed out that higher education establishments seldom have equipment or qualified staff available for undertaking, or even advising on, the production of tapes that reflect the latest technological advances.

Finally, we should give students as many opportunities as possible to present their work to various kinds of audience (students, teachers, and researchers, professionals) with specific restrictions such as time-limits or the use of audio-visual equipment. Training in organizing and leading debates should not be disregarded, especially in highlighting group project work or seminars. In this respect, it is clearly useful to have a video recorder available to improve students' oral techniques.

All these tasks should help to make students producers of knowledge rather than mere consumers. They must embark on their careers equipped with the real ability to communicate so that they can pass on the results of their work.

(e) Some problems that arise in connection with training in specialized information and documentation management

We feel we should now broaden the scope of our discussion because the techniques and strategies used to train engineers in specialized information and documentation management cannot be determined without taking other restrictions into account.

Information documentation and the overall organization of the training programme

The examples given above concerning the National Institute of Agronomics show that the activities which help to train students in specialized information management are fitted into the general teaching programme.

This seems to us to form part of a general rule. We could discuss ad infinitum the best ways of introducing the techniques of handling specialized information into engineering education, not to mention the most appropriate time to do so. But in actual fact any choices we might make in this respect cannot disregard the general organization of the teaching programme in the establishment concerned.

For information management training to be fully effective, it should, then, fit into the 'macropedagogics' of the establishment, that is to say, the general organization of courses and curricula, as reflected most clearly in the timetables. It seems to us that this is an essential condition for making this knowledge part of an engineer's panoply of skills, a full-scale component of his or her training.

Information, documentation and the surroundings of the training establishment

We have already shown, in connection with the training strategy of the National Institute of Agronomics, the advantages derived from having a variety of information sources and skills close at hand.

But here again, it is clear that this can be argued on a broader scale than this one example. The location of higher education establishments plays a major part in how documentation techniques, literature searching and specialized information management are taught in actual practice.

The proximity of different kinds of research laboratory, professional organizations, technical institutions, innovative companies, government offices and documentation centres on the same campus or in the same town, obviously provides excellent conditions for introducing an active learning process that requires students to work on their own initiative and through which they learn to locate, handle and make optimum use of a wide range of information sources and professional skills.

This shows that the location of higher education establishments is still of major importance and always involves some basic educational issues. The growth in on-line consultation of data bases and data banks, even setting aside the considerable cost involved, does not solve all the problems that arise: access to primary documents, the importance of students having personal contact with researchers, professionals and experts, the fertile relations between the institution and its scientific and economic environment, and so on.

How the role of the teacher is changing

Finally, it is important to be aware of the changing role of teachers in higher education establishments and the need for adaptation as their working environment alters and new technologies for the processing, transmission and consultation of information continue to spread.

Educational technology, in the broad sense, is constantly improving, making it possible and indeed necessary to change our approach to training. Students are increasingly able to consult certain sources of knowledge as and when they feel the need, and this process is bound to become more widespread and effective in future.

Moreover, teachers are no longer the only vectors of knowledge - not by a long way. Indeed, they find themselves caught up in a permanent process of readjustment, in the light of the many sources of knowledge available to their students, the content of courses produced and made available by others, and the skills possessed by others which may complement, or compete with their own.

In other words, it is essential for higher education establishments to stimulate and organize, on a permanent basis, a process of reflection on the role of the teacher and the practice of teaching. If teachers are still to play a central part in their students' education, they must be willing to undertake the constant review not only of their knowledge and the tools and methods used to transmit it, but, in addition, of the approaches and practices involved in this transmission process. Training is less and less a matter for teachers alone from this standpoint, the idea of joint training schemes is rich in possibilities.

ANNEX

Bibliography and contributions

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Helsinki University of Technology
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Sri WIDATOEN DARJOTO
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Committee on Engineering Information
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3. INDIVIDUAL CONTRIBUTIONS BY PROFESSION

Various contributions made by people working in different professional fields, either in or outside the higher education establishment concerned.

(a) **Librarians and documentalists**

working in libraries and documentation centres at technical universities or engineering colleges

25 contributions

(b) **Professors of scientific or engineering disciplines and heads of engineering colleges**

teaching in technical universities or engineering colleges

17 contributions

(c) **Practising engineers and engineering professionals**

working in industrial companies or national engineering associations

8 contributions

(d) **Specialists in information science or educational theory**

working in university establishments or research centres

4 contributions

4. INSTITUTIONAL CONTRIBUTIONS BY COUNTRY

Contributions were made by institutions in many different countries:

AFRICA	**3 institutions**
Benin	1
Senegal	1
United Republic of Tanzania	1
AMERICA	**5 institutions**
Canada	2
United States of America	3
ASIA AND OCEANIA	**3 institutions**
Australia	1
Indonesia	2
ARAB STATES	**2 institutions**
Algeria	1
Jordan	1
EUROPE	**29 institutions**
Belgium	1
Finland	2
France	11
Hungary	2
Ireland	1
Netherlands	2
Poland	1
Portugal	1
Spain	1
Sweden	1
United Kingdom	6